BEFORE THE PUBLIC UTILITIES COMMISSION OF THE

STATE OF CALIFORNIA

Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements.	Rulemaking 16-02-007 (Filed February 11, 2016)

<u>INTEGRATED RESOURCE PLAN OF</u>
<u>SOUTHERN CALIFORNIA EDISON COMPANY (U 338-E)</u>

PUBLIC VERSION

JANET S. COMBS
CATHY A. KARLSTAD

Attorneys for
SOUTHERN CALIFORNIA EDISON COMPANY

2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770
Telephone: (626) 302-1096
Facsimile: (626) 302-1910
E-mail: Cathy.Karlstad@sce.com

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Table Of Contents

Section	Page

Section	Page

Section	Page

Section	Page

Section	Page

Section	Page

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Pursuant to Ordering Paragraph ("OP") 1 of Decision ("D.") 18-02-018, Southern California Edison Company ("SCE") respectfully submits its Integrated Resource Plan ("IRP") for the 2017-2018 cycle to the California Public Utilities Commission ("Commission" or "CPUC").

I.

EXECUTIVE SUMMARY

A.   The IRP Process is an Important Part of Facilitating California's Decarbonized Future

Senate Bill ("SB") 350's IRP process represents a fundamental change in California's approach to resource planning. Historically, the Commission's long-term procurement planning focused on identifying the supply-side resources needed to ensure grid reliability in a cost-effective manner. In contrast, the principal objective of the IRP process is helping California

meet its 2030 greenhouse gas ("GHG") emissions reduction target.[1] Additionally, the Legislature tasked the Commission with ensuring that load-serving entities' ("LSEs") IRPs "[e]nsure system and local reliability," "[m]inimize impacts on ratepayers' bills," "[e]nable each electrical corporation to fulfill its obligation to serve its customers at just and reasonable rates," and "[m]inimize localized air pollutants and other greenhouse gas emissions, with early priority on disadvantaged communities."[2]

By initiating an integrated planning process for all LSEs, designed to identify the optimal mix of all supply- and demand-side resources to cost-effectively meet GHG emissions targets and other state goals while ensuring grid reliability, the IRP process should provide strong central coordination and balanced tradeoffs across all resource options. If the IRP process takes an economy-wide view and considers all meaningful energy end uses, it also has the potential to result in more efficient planning decisions across California's economic sectors and to reduce health-harming criteria pollutant emissions from fossil fuel end uses.

Development of an effective IRP process is a significant undertaking. SCE appreciates the challenges in establishing a new and more comprehensive resource planning process and commends the Commission, its staff, and the parties for the important work that has been completed over the last two years. As expected at this stage, there is still much work to be done to ensure that the IRP process will successfully support achievement of California's economy-wide climate goals in 2030 and beyond. SCE discusses some of that additional work throughout this IRP.

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[1] *See* Cal. Pub. Util. Code §§ 454.51(a) (the portfolio of resources identified by the Commission "shall rely upon zero carbon-emitting resources to the maximum extent reasonable and be designed to achieve any statewide greenhouse gas emissions limit"), 454.52(a)(1)(A) (the Commission shall ensure IRPs meet GHG emissions reduction targets that reflect the electric sector's percentage in achieving economy-wide GHG emissions reductions of 40% from 1990 levels by 2030).

[2] Cal. Pub. Util. Code §§ 454.52(a)(1)(C)-(E) and (H).

In this IRP filing, SCE requests the following:

- The Commission should approve SCE's preferred portfolio, which targets SCE's bundled customer share of an overall 2030 electric sector GHG emissions planning target of 28 million metric tons ("MMT") and incorporates higher transportation and building electrification than assumed in the Commission's Reference System Plan, and authorize SCE to begin procurement of the resources in that portfolio. SCE seeks this authorization if two conditions are met: (1) adoption of a 2030 electric sector GHG emissions planning target of 28-30 MMT[3] and higher electrification assumptions consistent with SCE's Clean Power and Electrification Pathway for all LSEs filing IRPs; and (2) adoption of the investor-owned utilities' ("IOUs") Green Allocation Mechanism and Portfolio Monetization Mechanism ("GAM/PMM") proposal or a similar equitable departing load cost allocation mechanism for replacing the Power Charge Indifference Adjustment ("PCIA") methodology in Rulemaking ("R.") 17-06-026.

- To the extent SCE's Clean Power and Electrification Pathway approach is not adopted in the 2017-2018 IRP cycle, SCE urges the Commission to include cross-sector modeling and analysis in the next IRP cycle to develop an economy-wide, optimized view of how the entire state plans to meet California's 2030 GHG

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[3] Under SB 350, the California Air Resources Board ("CARB") has statutory authority to set GHG emissions targets for the electric sector and individual LSEs and local publicly owned electric utilities, in coordination with the Commission and California Energy Commission ("CEC"). *See* Cal. Pub. Util. Code §§ 454.52(a)(1)(A), 9621(b)(1). In a July 2018 Staff Report, CARB staff identified an electric sector target of 30-53 MMT of GHG emissions for 2030, the lower bound of which represents an emissions target associated with achieving the state's goals with defined policy measures rather than relying on undefined market-based solutions. *See* CARB, *Staff Report: Senate Bill 350 Integrated Resource Planning Electricity Sector Greenhouse Gas Planning Targets*, July 2018, at 23, available at: https://www.arb.ca.gov/cc/sb350/staffreport_sb350_irp.pdf. CARB voted to approve this target range at its July 26, 2018 meeting. SCE's preferred portfolio was developed based upon a slightly lower 2030 electric sector GHG emissions planning target (28 MMT) than the CARB lower bound. Because SCE recognizes that the Commission may not have authority to establish targets for its jurisdictional LSEs that are below CARB's lower bound, SCE's request is for 28 MMT to 30 MMT, the lower bound of CARB's range.

emissions target. Based on its analysis, SCE strongly believes a more stringent 2030 electric sector GHG emissions planning target of 28-30 MMT and higher levels of electrification will be necessary to effectively facilitate achievement of the state's 2030 GHG emissions goal.

- The Commission should forward SCE's alternative deep decarbonization, high electrification California Independent System Operator ("CAISO") system-wide plan to the CAISO to study as a policy-driven case in its 2019-2020 Transmission Planning Process ("TPP"). In addition to studying transmission system impacts, the CAISO should study the reliability effects of reductions in revenue for natural gas plants, the potential economic retirements of such plants, and the ability of the natural gas system to meet electric generation plant demand under both the Commission's Reference System Plan and SCE's alternative CAISO system-wide plan.

- The Commission should approve SCE's proposal for a reliability threshold mechanism that can be used for expedited procurement (up to 50% utility-owned for SCE) and deployment of flexible energy storage resources to address reliability issues if they emerge prior to the decision on the next IRPs.

Each of these requests is discussed in more detail in this Executive Summary.

B. **The Commission Should Pursue an Integrated, Economy-wide Path to Reducing California's GHG Emissions and Air Pollutants**

1. **Achieving California's GHG Emissions and Air Quality Goals Requires Urgent Action**

Climate change poses serious threats, and its impacts, such as sea level rise, longer and more intense heat waves, changes in precipitation patterns, and wildfires are already escalating. While significant progress has been made to reduce air pollution, too many communities continue to experience asthma and other air quality-related health issues.

California has taken a leadership role in addressing the dangers of climate change and air pollution. The state set aggressive goals to reduce GHG emissions by 40% from 1990 levels by 2030, and 80% from 1990 levels by 2050.[4] California reduced its GHG emissions 13% from their peak in 2004 and is now below 1990 GHG emissions levels and the state's 2020 target.[5] However, meeting 2030 requirements and 2050 goals will require even more aggressive GHG emissions reductions. Moreover, state and local air quality targets include significant reductions in nitrogen oxides ("NOx") and other health-harming pollutants by 2032 in areas of the state with the highest levels of air pollution.[6] Meeting these pressing goals will require fundamental changes across all sectors of the economy. No individual sector can achieve them alone. Figure I-1 below shows each economic sector's share of California's total 2016 GHG emissions and the emissions reductions needed to meet the state's 2030 and 2050 emissions goals.[7]

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[4] *See* SB 32 (2016); Exec. Order S-3-05 (2005).

[5] *See* CARB, *California Greenhouse Gas Emissions for 2000 to 2016, Trends of Emissions and Other Indicators*, 2018 Edition, at 2, available at: https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2016/ghg_inventory_trends_00-16.pdf.

[6] For example, in the South Coast Air Basin, meeting ozone standards will require an approximate 70% reduction from today's levels of NOx by 2023, and an overall 80% reduction by 2031. *See* CARB, *Revised Proposed 2016 State Strategy for the State Implementation Plan*, March 7, 2017, at 23, available at: https://www.arb.ca.gov/planning/sip/2016sip/rev2016statesip.pdf.

[7] *See* CARB, *California Greenhouse Gas Emissions Inventory for 2000-2016 – by Sector and Activity*, June 22, 2018, available at: https://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_sector_sum_2000-16.pdf.

Figure I-1
California's GHG Emissions Goals
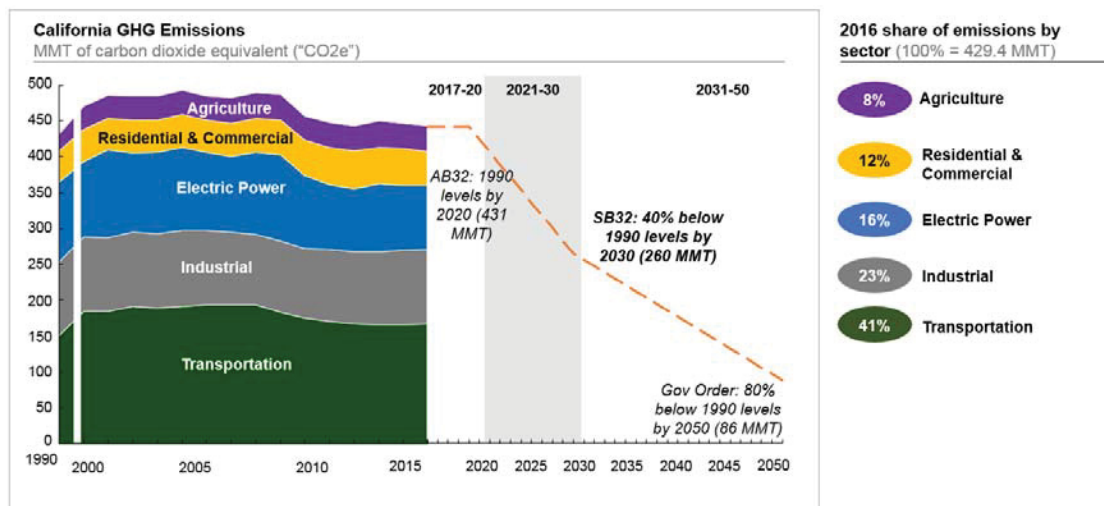
The electric sector has been at the forefront of the fight against climate change in California. As of 2016, the electric sector reduced its GHG emissions by 40% from the height of California's emissions in 2004, and has provided the majority of emissions reductions in the state since 1990.[8] As noted above, the electric sector currently accounts for only 16% of statewide GHG emissions and reduced its emissions 18% in 2016 compared to 2015.[9] The electric sector will further reduce its emissions as it meets a 50% Renewables Portfolio Standard ("RPS"); as customers continue to adopt distributed energy resources ("DERs") and they increasingly help to meet the electric grid's needs; and as the IRP process identifies additional opportunities to reduce emissions in a way that minimizes impacts on customers' bills.

The future role of the electric sector is also transforming. In addition to reducing its own GHG footprint and generating cleaner electricity, the electric sector offers opportunities for more reductions in GHG emissions and air pollutants in the state by enabling electrification in other

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[8] *See id.*; CARB, *Staff Report, California 1990 Greenhouse Gas Emissions Level and 2020 Emissions Limit*, November 16, 2007, at 6, available at: https://www.arb.ca.gov/cc/inventory/pubs/reports/staff_report_1990_level.pdf.

[9] *See* CARB, *California Greenhouse Gas Emissions for 2000 to 2016, Trends of Emissions and Other Indicators*, 2018 Edition, at 7, available at: https://www.arb.ca.gov/cc/inventory/pubs/reports/2000_2016/ghg_inventory_trends_00-16.pdf.

sectors, and encouraging customer adoption of electricity-powered end use products such as light-, medium-, and heavy-duty vehicles and space and water heating for buildings. In contrast to the electric sector, the transportation sector represents 41% of California's GHG emissions and is the largest GHG-emitting segment in the state.[10] GHG emissions from transportation sources increased by 4% between 2014 and 2016.[11] Further, the residential and commercial sectors create 12% of statewide GHG emissions and represent a viable opportunity for fossil fuel end use reduction via electrification of space and water heating.[12] Accordingly, fostering policies that recognize the electric sector's ability to facilitate electrification to displace end uses of fossil fuels, in addition to reducing power supply emissions, is critical to cost-effectively meet California's environmental goals in 2030 and beyond.

This is a decisive moment – 2030 is just over 11 years away. Timely, proactive decision-making by policymakers and leaders, and expeditious alignment among stakeholders on near-term priorities and market transformation activities, are required if the state is going to meet its ambitious schedule for reducing GHG emissions and improving air quality. LSEs, and in particular the IOUs, require regulatory approval for GHG reduction measures beyond current policies to allow the electric sector to pursue deeper decarbonization and serve as an enabler of GHG reductions across other sectors of the economy. To achieve this degree of decarbonization in the electric sector, long-term investments are needed to develop new renewable resources and energy storage. These resources, and any required transmission, may take several years to develop. Sufficient lead time is also needed to supplant fossil fuel-powered vehicles and space and water heaters with electricity-powered technologies. Accordingly, the IRP process must support a highly decarbonized electric sector with high electrification to encourage LSEs to make the long-term investments and potentially guide the re-investment of cap-and-trade

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[10] *See id.* at 4.
[11] *See id.* at 6.
[12] *See id.* at 4.

program funds to pursue further GHG reduction in the electric sector and facilitate GHG reduction in other sectors.

SCE has embraced its role as one of California's largest utilities to partner with legislators, regulators, communities, and other interested stakeholders to achieve California's GHG emissions and air pollution reduction goals at the lowest reasonable cost while delivering – and ideally, improving – safe and reliable electric service. As discussed below, SCE has developed a holistic, systematic approach to reaching California's 2030 GHG emissions goal that identifies the actions required to cost-effectively meet that goal with actions across all key sectors of the economy.

2.   **SCE's Analysis Demonstrates That Cost-Effectively Meeting the State's 2030 GHG Emissions Goal Requires a More Stringent Electric Sector GHG Emissions Planning Target and Higher Electrification**

For the 2017-2018 IRP cycle, the Commission adopted a GHG emissions planning target for the electric sector of 42 MMT by 2030.[13] The Commission's plan assumes relatively low levels of electrification in the transportation and building sectors – only 3.3 million light-duty electric vehicles ("EVs") by 2030 and no building electrification. The Commission forwarded the portfolio associated with the 42 MMT target to the CAISO as the policy-driven case to be used in the CAISO's 2018-2019 TPP.[14] SCE has concluded that a more aggressive electric sector GHG emissions planning target and higher electrification in the transportation and building sectors are necessary for California to achieve its 2030 GHG emissions goal at the most reasonable cost.

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[13] *See* D.18-02-018 at 57-59, Finding of Fact ("FOF") 4, Conclusion of Law ("COL") 12. The CAISO system represents approximately 80% of the load share of all electric retail providers in the state; therefore, the CAISO system GHG emissions planning target is assumed to be 33.6 MMT of the 42 MMT electric sector target.

[14] *See* D.18-02-018 at 104-105, FOF 12, COL 23, OP 11.

In November 2017, SCE released *The Clean Power and Electrification Pathway* whitepaper, setting forth a proposed integrated, economy-wide approach to realize California's 2030 GHG emissions target and advance the state's air quality goals by taking action in three key economic sectors: electricity, transportation, and buildings.[15] Multiple paths exist for California to reach its 2030, and ultimately 2050, climate goals, and each has varying levels of cost and technical feasibility. SCE analyzed various GHG abatement measures to better understand the GHG reduction potential, costs, feasibility, and trajectories of different scenarios. SCE determined that the Clean Power and Electrification Pathway ("Pathway") is the most achievable and least-cost approach to meet California's 2030 GHG emissions target while maintaining reliability. Indeed, the Pathway is significantly lower cost than other strategies for reaching the state's 2030 target. Implementing the Pathway would also reduce air pollution in California and put the state on course towards its 2050 GHG emissions goal.

SCE's GHG scenario analysis entailed finding the lowest cost and most feasible economy-wide scenario that explicitly achieves California's 2030 GHG emissions limit of 260 MMT. A cross-sector, economy-wide approach is essential because the best GHG reduction strategies in other sectors (e.g., electrification to displace some end uses of fossil fuels) may depend upon the electric sector's GHG abatement activities, but also affect the electric sector's GHG emissions levels due to increased load. Therefore, the optimal solution for reducing GHG emissions statewide cannot be found if each economic sector is viewed in isolation.

SCE's analysis indicated that the optimal scenario by 2030 – the Pathway – is an electric grid supplied by 80% carbon-free energy, more than 7 million EVs on California roads, and using electricity to power nearly one-third of space and water heaters in increasingly energy-

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[15] *See* Appendix A, *The Clean Power and Electrification Pathway*, November 2017.

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efficient buildings.[16] This scenario yields 28 MMT of GHG emissions in 2030 from the electric sector after accounting for the increased load from cross-sector electrification, reduced load from energy efficiency measures, and deeper decarbonization of electric generation. SCE concluded that the best approach for achieving California's 2030 goal includes much higher electrification of transportation and buildings and more carbon-free energy than assumed under the Commission's 42 MMT GHG emissions planning target for the electricity sector.

SCE is not alone in recognizing deeper decarbonization of the electric sector and electrification of the transportation and building sectors as necessary elements of a feasible and reasonable cost blueprint for achieving California's 2030 GHG emissions target. The Governor has called for 5 million zero-emission vehicles ("ZEVs") in California by 2030.[17] Moreover, the CEC's Energy Research and Development Division recently published *Deep Decarbonization in a High Renewables Future*, a report considering various GHG mitigation strategies for California to meet its long-term climate goals in 2030 and 2050.[18] One of the scenarios considered was a High Electrification Scenario including 74% zero-carbon electricity, 6 million ZEVs, and a 50% market share of electric space and water heat pump sales in 2030.[19] The report states the High Electrification Scenario "meets the state's climate goals using a plausible combination of greenhouse gas mitigation technologies" and "is one of the lower-cost, lower-risk mitigation scenarios."[20]

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[16] SCE's commitment to cross-sector GHG reduction is underscored in SCE's recently filed Charge Ready 2 application, Application ("A.") 18-06-015, to continue and expand the ongoing Charge Ready program, which aligns with SCE's Pathway target of 7 million EVs by 2030. SCE proposes to implement a portfolio of programs aimed at accelerating light-duty EV adoption by making EV charging available to more customers, addressing barriers to EV adoption, and promoting EV awareness and grid benefits. EVs are critical to California's comprehensive climate and air quality plans and achieving the state's 2030 GHG emissions target.

[17] *See* Exec. Order B-48-18 (2018).

[18] *See* CEC Energy Research and Development Division, *Deep Decarbonization in a High Renewables Future*, June 2018, available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=223785.

[19] *See id.* at 18.

[20] *Id.* at 2-4.

C. **Based on SCE's Economy-wide GHG Scenario Analysis, SCE Developed an Alternative SCE Pathway System Plan, an SCE Preferred Portfolio with an Associated Action Plan, and the Required Conforming Portfolio**

SCE has developed two plans for this filing: (1) a CAISO system plan based on SCE's Pathway for meeting California's 2030 GHG emissions goal, including a 28 MMT GHG emissions planning target for the electric sector ("SCE Pathway System Plan") and the associated SCE bundled portfolio based on the targets and constraints in the SCE Pathway System Plan applied at the SCE bundled level ("SCE Preferred Portfolio"); and (2) an SCE bundled portfolio using inputs and assumptions from the Commission's Reference System Plan and the 2017 Integrated Energy Policy Report ("IEPR"), including the Commission's 42 MMT GHG emissions planning target for the electric sector ("SCE Conforming Portfolio"). The fundamental difference between these two plans is that SCE's Pathway is constructed from a multi-sector GHG scenario analysis that defines explicit GHG reduction activities across the economy to meet California's 260 MMT, economy-wide 2030 GHG emissions target. SCE's Pathway meets or exceeds the main objectives of SB 350.[21] The Commission's Reference System Plan does not provide clarity on how it satisfies the state's 260 MMT, economy-wide 2030 GHG emissions target; therefore, it is unclear how the SCE Conforming Portfolio helps to meet that objective.

In SCE's economy-wide Pathway approach, SCE identified the set of least-cost, feasible measures for the California economy to meet the objectives of SB 350, established the electric sector GHG emissions planning target in the context of attaining California's economy-wide 2030 GHG emissions target, quantified the impact of the measures on electric system load, and

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[21] SB 350 established that achieving California's 2030 GHG emissions reduction target of 40% below 1990 levels is the principal objective of the IRP process, increased California's RPS goal from 33% by 2020 to 50% by 2030, and required the state to double statewide energy efficiency savings by 2030. *See* Cal. Pub. Util. Code §§ 399.15(b)(2)(B), 399.30(c)(2). 454.51(a), 454.52(a)(1)(A), 9621(b)(1); Cal. Pub. Res. Code § 25310(c)(1).

identified the electric system resources needed to meet the electric sector load and GHG emissions planning target cost-effectively while satisfying reliability constraints.

Table I-1 below details the planning assumptions and resulting outputs for both scenarios, demonstrating the holistic and comprehensive approach that SCE has taken in developing its SCE Preferred Portfolio. The Commission's Reference System Plan (and the SCE Conforming Portfolio based on that plan) do not define decarbonization measures in other sectors of the economy, other than by assuming the GHG reductions set forth in California's 2017 Climate Change Scoping Plan ("2017 Scoping Plan") will take place. Consequently, they do not account for the interlinked impact of those measures on the electric sector, leaving a large planning gap that the SCE Pathway System Plan (and the SCE Preferred Portfolio based on that plan) address.

Table I-1
Comparison of SCE Pathway System Plan and Reference System Plan

	SCE Pathway System Plan	Reference System Plan
Economy-wide Analysis: Assumptions and Results		
2030 California Economy-wide GHG Emissions Target	260 MMT	N/A
Economy-wide CO2e Dollars per Metric Ton ("MT") Incremental Abatement Cost from Current Policy Scenario[22]	$79/MT	N/A
2030 Light-duty EV Adoption	6.8 million	3.3 million
2030 Building Electrification	Up to 30% electrification of space and water heating	No incremental building electrification
Electric Sector: Assumption Impacts		
2030 Electric Sector GHG Emissions Planning Target	28 MMT for California 22.4 MMT for CAISO System	42 MMT for California 34 MMT for CAISO System
2030 CAISO EV Load (Gigawatt-hours ("GWh"))	24,432	11,261
2030 CAISO Energy Efficiency (GWh)	41,315	28,191
2030 CAISO Behind-the-Meter ("BTM") Photovoltaic ("PV") (GWh)	36,534	33,635
2030 CAISO Net Load (GWh)	188,558	202,444
Planning Outputs		
Renewable Additions (Cumulative Megawatts ("MW") for CAISO System – 2030)	16,044	9,862
Energy Storage Additions (Cumulative MW for CAISO System – 2030)	9,604	2,104
Average SCE Residential Bill 2030 (Nominal)	$150	$137

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[22] More details on this incremental abatement cost and the Current Policy Scenario are included in Section II.B.1.

1. Summary of the SCE Pathway System Plan and the SCE Preferred Portfolio and Procurement Action Plan

As noted above, SCE's IRP includes an alternative CAISO system plan based on SCE's Pathway for meeting California's 2030 GHG emissions goal – the SCE Pathway System Plan. SCE developed the SCE Pathway System Plan using the 28 MMT by 2030 electric sector GHG emissions level that resulted from SCE's economy-wide GHG scenario analysis. In addition, the SCE Pathway System Plan takes into account the load effects of the GHG-reducing transportation and building electrification included in the Pathway, current policies that encourage BTM PV adoption, and statutory requirements for energy efficiency. The SCE Pathway System Plan indicates that cumulative resource additions of approximately 16 gigawatts ("GW") of renewable generation capacity and nearly 10 GW of energy storage will be needed in the CAISO system by 2030.[23]

Based on the targets and constraints in the SCE Pathway System Plan, applied at the SCE bundled level, SCE also developed an SCE bundled portfolio as its preferred portfolio in this IRP – the SCE Preferred Portfolio. The SCE Preferred Portfolio shows modeled cumulative resource additions of approximately 4.2 GW of renewable generation capacity and 1.6 GW of energy storage by 2030. Approximately 2.2 GW of the renewable resource additions occur between 2022 and 2024.[24] The SCE Preferred Portfolio assumes the IOUs' GAM/PMM proposal[25] for replacing the PCIA[26] methodology in R.17-06-026 will be adopted by the Commission, which will ensure that an equitable and optimal allocation of legacy IOU portfolio resources occurs

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[23] Although SCE's resource portfolios include modeled optimal mixes of resources based on the model assumptions, the need is for carbon-free energy and energy storage, not a particular mix of resources.

[24] These renewable resources are not needed until later years to meet GHG emissions targets. They are added early due to the cost optimization in the model.

[25] *See* IOUs' *Power Charge Indifference Adjustment Prepared Testimony*, R.17-06-026, April 2, 2018.

[26] "PCIA" is the colloquial term for the current methodology that attempts to determine the above-market costs of the IOUs' power procurement portfolios and recover them from departing load customers through the PCIA rate and the ongoing Competition Transition Costs rate.

regardless of the levels of departing load. As described later, the SCE Preferred Portfolio would change if a different mechanism is adopted.

SCE is prepared to pursue its share of the deeper electric sector decarbonization that is needed to reach California's 2030 GHG emissions goal. To that end, SCE requests authority to begin procurement of the resources in the SCE Preferred Portfolio if two conditions are met: (1) adoption of a 2030 electric sector GHG emissions planning target of 28-30 MMT[27] and higher electrification assumptions consistent with SCE's Pathway for all LSEs filing IRPs; and (2) adoption of the IOUs' GAM/PMM proposal (or a similar equitable departing load cost allocation mechanism) to replace the PCIA methodology. SCE proposes that unless and until these two conditions are met, SCE would necessarily procure under its conforming portfolio as discussed below, so as not to risk potentially higher shifting of costs from departing load customers to those customers who continue to receive bundled service from SCE.

SCE developed the SCE Pathway System Plan and selected the Pathway-based SCE Preferred Portfolio in this IRP to illustrate the mix of resources that will ultimately be needed to meet California's 2030 GHG emissions goal. But SCE cannot achieve that goal alone. The entire electric sector, and the broader California economy, must move together if the state is going to reduce GHG emissions 40% below 1990 levels by 2030. The SCE Pathway System Plan and SCE Preferred Portfolio were created with the assumption that other LSEs would take action based on the GHG emissions planning target and higher electrification assumptions of the Pathway. The measures will not work if only SCE acts based on the Pathway approach. Additionally, while SCE believes its Pathway will allow achievement of California's 2030 GHG emissions target at the lowest reasonable cost, the transition to a highly decarbonized future comes at a cost, and SCE's bundled service customers cannot bear that cost alone.

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[27] As explained in footnote 3, given that the Commission may not have authority to establish GHG emissions planning targets for its jurisdictional LSEs that are below the lower bound of the range established by CARB, SCE's request is for 28 MMT to 30 MMT, the lower bound of CARB's range.

The SCE Preferred Portfolio also assumes the IOUs' GAM/PMM proposal will be adopted as a replacement for the current PCIA methodology. If the current PCIA remains in place, the level of resource additions in the SCE Preferred Portfolio would not be needed because SCE would retain its existing resource portfolio as load departs. SCE's request to begin procurement under the SCE Preferred Portfolio is also conditioned on adoption of the GAM/PMM or a similar equitable departing load cost allocation mechanism that achieves true indifference to departing load for all customers. Such a mechanism is necessary to prevent unlawful cost shifting to SCE's bundled service customers. According to the Commission, up to 85% of the historical retail customer base of the three IOUs could leave utility bundled service to have their energy provided by alternative energy providers or other non-IOU sources, principally community choice aggregators ("CCAs").[28] With that level of anticipated departing load, SCE and the other IOUs need a cost allocation mechanism for departing load charges that ensures cost indifference for all customers as required by law.[29] Otherwise, the long-term procurement needed to achieve California's environmental goals will only exacerbate the unlawful cost shifts to IOU bundled service customers.

2. **Summary of the SCE Conforming Portfolio and Procurement Action Plan**

In accordance with D.18-02-018, SCE's IRP includes an SCE bundled portfolio using inputs and assumptions from the Commission's Reference System Plan and the 2017 IEPR – the SCE Conforming Portfolio. The SCE Conforming Portfolio assumes the PCIA methodology will remain in place. Based on those assumptions, the SCE Conforming Portfolio shows no resource additions through 2030, because SCE can meet its GHG emissions targets and other needs with existing and contracted resources.

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[28] *See* Commission, *Consumer and Retail Choice, the Role of the Utility, and an Evolving Regulatory Framework, Staff White Paper*, May 2017, at 3, available at: http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/News_Room/News_and_Updates/Retail%20Choice%20White%20Paper%205%208%2017.pdf.

[29] *See* Cal. Pub. Util. Code §§ 365.2, 366.2, 366.3.

Although the SCE Conforming Portfolio is not SCE's recommended approach, SCE will manage its bundled service customer portfolio consistent with the SCE Conforming Portfolio until the two conditions for beginning procurement under the SCE Preferred Portfolio are met. SCE has no need for procurement in this IRP cycle under the SCE Conforming Portfolio, and potentially for a number of years depending on the level of departing load it experiences. However, adoption of the IOU's GAM/PMM proposal will create a need for additional procurement as SCE's legacy portfolio will be equitably and efficiently allocated for the benefit of all customers.[30]

3. **The CAISO and the Commission Should Undertake Further Studies to Plan for a Highly Decarbonized, Safe, and Reliable Electric Grid**

In addition to SCE's proposed procurement action plan, SCE's IRP includes recommendations for studies that will help position the state to cost-effectively move towards a deeply decarbonized future while continuing to deliver safe and reliable electric service. As discussed above, supporting achievement of California's 2030 GHG emissions target is the overarching purpose of IRP. Ensuring system and local reliability also remains a core IRP responsibility.[31] To meet these objectives, state policymakers must plan for a 2030 electric grid that includes high levels of zero-carbon electricity (80% under SCE's Pathway), high levels of electrification (more than 7 million EVs and nearly one-third of space and water heating under SCE's Pathway), and a significant amount of energy storage (nearly 10 GW under the SCE Pathway System Plan).

In developing the SCE Pathway System Plan, SCE chose representative locations for new resources that minimized the need for policy-driven transmission projects and maximized the full delivery of incremental renewables. Nonetheless, it is important for the CAISO to complete a

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[30] If the IOUs' GAM/PMM proposal is adopted, the resource additions in the SCE Conforming Portfolio would change and additional renewable resources would be added in the near-term.

[31] *See* Cal. Pub. Util. Code §§ 454.51(a), 454.52(a)(1)(E).

thorough study of a high renewables, high electrification case like the SCE Pathway System Plan in the TPP to: (1) determine the transmission system impacts of the SCE Pathway System Plan for the entire CAISO footprint; (2) begin discussions to modify or augment generation interconnection or procurement processes to maximize transmission utilization; (3) consider energy storage as an option to meet identified needs (both generation and transmission); and (4) provide the necessary lead time to develop policy-driven transmission lines if required. SCE requests that the Commission forward the SCE Pathway System Plan to the CAISO to study as a policy-driven case in its 2019-2020 TPP. If needed, new transmission projects require long lead times (seven years or more) to plan, approve, and build. Therefore, it is vital to expeditiously study the transmission needs of a high renewables and electrification scenario so that the Commission, the CAISO, LSEs, and other stakeholders have the information needed to guide future investment decisions.

Further, other than once-through cooling ("OTC") plants scheduled for retirement, the Commission's Reference System Plan assumes that all natural gas plants, including planned additions through new local capacity requirements ("LCR") procurement conducted by SCE and San Diego Gas & Electric Company ("SDG&E"), will be available for the planning horizon. The Commission recognized that this assumption was "criticized by many parties" and is a "simplifying assumption that does not necessarily reflect reality."[32] SCE also notes that delays or other issues with the timely development of the new resources procured through the existing LCR process present a risk.[33]

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[32] D.18-02-018 at 145.
[33] For example, the CEC permitting process was suspended for the 262 MW Puente project that SCE contracted for through its LCR Request for Offers ("RFO") to meet LCR needs for the Moorpark sub-area. Therefore, on February 28, 2018, SCE launched the Moorpark LCR/Goleta Resiliency Request for Proposals ("RFP") to address the resulting LCR shortfall in the Moorpark sub-area. The timeline for this solicitation is extremely compressed, and increases the risk that needed resources may not be available in time to replace retiring OTC plants.

In addition, natural gas system constraints not considered in the 2017-2018 IRP cycle may affect the ability of the natural gas fleet to meet system and/or local reliability needs. For instance, the recent challenges to Southern California Gas Company ("SoCalGas") system deliverability due to the de-rating of the Aliso Canyon natural gas storage facility and other recent unplanned pipeline outages may impair the ability of the system to deliver the needed natural gas for electric generation plants.[34]

In D.18-02-018, the Commission stated that examination of impacts on the natural gas fleet in California "is an important policy area for further work."[35] SCE agrees, and recommends that the Commission ask the CAISO to analyze the system and local reliability impacts of reductions in revenue for natural gas plants and the potential economic retirements of such plants under both the Commission's Preferred System Plan and the SCE Pathway System Plan in the CAISO's 2019-2020 TPP. The ability of the natural gas system to meet electric generation plant demand under varying demand and system supply scenarios consistent with these plans should also be studied in the 2019-2020 TPP. The study should analyze the effects of the continuing restrictions on use of the Aliso Canyon natural gas storage facility and the impacts of pipeline outages on the ability to fill storage facilities to levels sufficient to ensure energy reliability throughout the summer and winter seasons. As California seeks to reduce reliance on GHG-emitting resources in support of its climate and air quality goals, the state needs to analyze these issues in order to develop a comprehensive transition plan that ensures system reliability is maintained (or enhanced) in the process.

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[34] *See* Commission, CEC, CAISO, and Los Angeles Department of Water and Power ("LADWP"), *Aliso Canyon Risk Assessment Technical Report Summer 2018*, May 7, 2018, available at: www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/About_Us/Organization/Divisions/News_and_Outreach_Office/Aliso%20Canyon%20Summer%202018%20Technical%20Assessment.pdf.

[35] D.18-02-018 at 145.

4. **The Commission Should Approve a Reliability Threshold Mechanism That Can be Used for Expedited Procurement and Deployment of Flexible Energy Storage Resources if System or Local Reliability Issues Arise**

SCE is concerned that the IRP work completed thus far has not fully considered the flexible resource availability needed to ensure system and local reliability. As mentioned above, the Commission assumed all natural gas plants (other than OTC plants scheduled for retirement) will remain in operation during the planning horizon. SCE also used this assumption in its IRP modeling. However, the Commission acknowledged this is a "simplifying assumption that does not necessarily reflect reality."[36] IRP modeling also did not consider natural gas system constraints or the potential default or delay of local capacity resources contracted in past solicitations, both of which could affect system and/or local reliability. These issues should be thoroughly evaluated in the next IRP cycle, in close cooperation with the CAISO, including through the TPP studies discussed above.

In the interim, SCE recommends that the Commission establish a process for expedited procurement and deployment of flexible energy storage resources to address reliability concerns on the electric grid should they arise. SCE proposes that the Commission adopt reliability thresholds based on specific events that may limit the reliability of the system, including significant unplanned near-term retirements of natural gas plants; local capacity resources procured in past solicitations not meeting their expected online dates, resulting in a local area shortfall; the CAISO declaring a Stage 2 Emergency (indicating an overall resource deficiency); or certain reductions in natural gas storage capacity or natural gas pipeline constraints. If any of these reliability thresholds are reached, the Energy Division, in conjunction with the CAISO, would conduct an expedited impact assessment to determine whether the event creates reliability concerns for the system. If the event does create a reliability issue that cannot be solved through

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[36] *Id.*

timely transmission solutions,[37] the Commission could then order accelerated procurement of energy storage to address the reliability concern.

Energy storage is the best option at this time to meet potential near-term reliability needs due to its flexibility and fast deployment capability. Both the Commission's Reference System Plan and the SCE Pathway System Plan show that energy storage is going to be an important part of the long-term solution to meeting California's 2030 GHG emissions goal, differing only on the timing and quantity based on the assumptions used. Thus, early deployment of flexible energy storage can be used as an effective tool to address near-term reliability issues, if any, while also serving the state's overall climate goals.

Additionally, the Commission should provide SCE the option to develop and own up to 50% of any procurement allocated to SCE under the reliability threshold mechanism. SCE can be prepared to rapidly utilize its existing right-of-ways to develop needed energy storage resources, bid and dispatch the energy storage resources for the benefit of all customers under the Commission's least-cost dispatch protocol, change the operating parameters of energy storage resources to address grid needs without needing to negotiate new contract terms with third-party owners, and retain the residual value of the energy storage resources for the benefit of customers. Although energy storage can be deployed relatively fast, traditional third-party procurement contracting and the Commission approval process add considerable time to the development process. Having a plan that allows for fast utility action to address near-term reliability issues can mitigate these concerns, while still relying on third-party contracting.

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[37] Transmission solutions could include optimally deploying energy storage as a transmission asset for the benefit of the system and all customers.

D. **SCE's Vision for Future IRP Cycles Includes an Economy-Wide Approach, More Alignment Among Agencies and Proceedings, and Full Integration of Supply- and Demand-Side Resources**

As the IRP develops as the central resource planning process for the electric sector to support achievement of California's GHG emissions goals, SCE makes the following three recommendations for future IRP cycles.

First, to the extent SCE's Pathway approach is not adopted in the 2017-2018 IRP cycle, SCE urges the Commission to include cross-sector modeling and analysis in the next IRP to develop an economy-wide, optimized view of how the entire state plans to meet California's 2030 GHG emissions target. This analysis must take into account the GHG abatement measures that need to take place in other sectors of the California economy and the effects of such measures on the electric sector. The Commission should establish the 2030 GHG emissions planning target for the electric sector and the assumptions regarding electrification of other sectors based on this cross-sector modeling and analysis. The Commission acknowledged that more analysis is needed to set GHG emissions planning targets that encourage cross-sector GHG reduction opportunities, including electrification.[38] Based on its analysis, SCE strongly believes a more stringent 2030 electric sector GHG emissions planning target of 28-30 MMT and higher levels of electrification will be necessary to effectively facilitate achievement of the state's 2030 GHG emissions goal.

It is crucial that the Commission not delay in developing an economy-wide strategy for achieving California's 2030 GHG emissions goal and approving the electric sector actions that are necessary to meet that goal. As discussed above, LSEs (and particularly IOUs) require regulatory approval of GHG reduction measures beyond current policies, and developing the amount of new renewable and energy storage resources (and any required transmission) needed

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[38] *See* D.18-02-018 at 57-58, 146-147.

to meet the state's 2030 GHG emissions target will take time. Prompt Commission action is required to establish a regulatory framework that will support statewide action to achieve California's climate goals in 2030 and beyond.

Second, the Commission should pursue greater intra- and inter-agency coordination to ensure the IRP process aligns and guides activities across relevant resource proceedings. SB 350 provides that "[t]o eliminate redundancy and increase efficiency," the IRP process "shall incorporate, and not duplicate, any other planning processes of the Commission."[39] In the Order Instituting Rulemaking for this proceeding, the Commission identified IRP "as a sort of umbrella resource planning proceeding designed to be informed by, and also possibly influence, a number of resource-specific proceedings also underway at the Commission," including those related to the RPS, energy efficiency, BTM solar, and energy storage.[40] SCE agrees with this vision and believes additional work should be undertaken in the next IRP cycle to better define how IRP will inform other resource proceedings and reduce duplication. Additionally, further alignment is needed between the IRP process and the planning activities of other agencies, including the CEC's IEPR, the CAISO's TPP, and the CARB's GHG accounting mechanisms.

Third, in the next cycle, the IRP process must fully integrate and optimize both supply- and demand-side resources as part of a robust common resource valuation methodology ("CRVM"). The Commission's model for this IRP is primarily capable of optimizing supply-side resources, but the Commission recognized the need to include all demand-side resources as candidate resources in future IRPs.[41] SCE agrees that optimizing all resources is necessary if the IRP process is going to identify the best path to achieve California's 2030 GHG emissions goal,

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[39] Cal. Pub. Util. Code § 454.52(d).
[40] *Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements*, R.16-02-007, February 11, 2016, at 3, 10-11.
[41] *See* D.18-02-018 at 34, 51-52.

and appreciates that Energy Division staff have begun efforts to more fully incorporate DERs into the IRP process in the Modeling Advisory Group.

E. **Organization of SCE's IRP**

SCE's IRP follows the Standard LSE Plan template adopted by the Commission in D.18-02-018 and further modified by Energy Division staff. Section II – Study Design describes how SCE approached the process of developing its IRP and discusses the objectives and methodology for SCE's IRP analytical work, including modeling tools, modeling approach, and assumptions. Section III – Study Results presents the results of SCE's IRP analytical work as described in Section II, including portfolio results and detailed information on the SCE Pathway System Plan, SCE Preferred Portfolio, and SCE Conforming Portfolio. Section IV – Action Plan describes the action plans, barrier analysis, and requests for Commission action associated with the SCE Preferred Portfolio and SCE Conforming Portfolio, as well as SCE's proposal for a reliability threshold mechanism that can be used for expedited procurement and deployment of flexible energy storage resources to address reliability issues. Section V – Data references the IRP data templates required by the Commission. Section VI – Lessons Learned discusses SCE's suggested changes to the IRP process for consideration by the Commission, including SCE's vision for future IRP cycles and additional lessons learned.

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II.

STUDY DESIGN

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SCE approached this IRP with the specific goal of offering a vision for how the electric sector should lead California in meeting its 2030 GHG emissions limit of 260 MMT. This vision is captured in the SCE Pathway System Plan, which is the final output of a series of analytical studies depicted below in Figure II-2.

In SCE's prior strategic planning work, it performed GHG scenario studies, which focused on developing a view of the most feasible and cost-effective GHG emissions reductions in all sectors of the California economy. The outputs of these studies included expected GHG

emissions for each sector and the impact of changes in one sector on other sectors, such as the effects of increases in transportation and building electrification on electric load. The results of this work were then combined with SCE-internal electric load and load growth forecasts to form a view of CAISO system electric sector demand in a scenario that complies with California's 2030 GHG emissions limit ("Pathway scenario"). Using this load forecast, along with GHG emissions objectives and cost minimization constraints, SCE optimized the CAISO system electric supply portfolio using capacity expansion modeling software. Lastly, SCE performed a series of iterative analyses to ensure that the prospective 2030 portfolio met GHG emissions targets and system operational requirements, including identification of impacts on the transmission system in SCE's transmission planning area.

Figure II-2
SCE's IRP CAISO System-wide Development Process
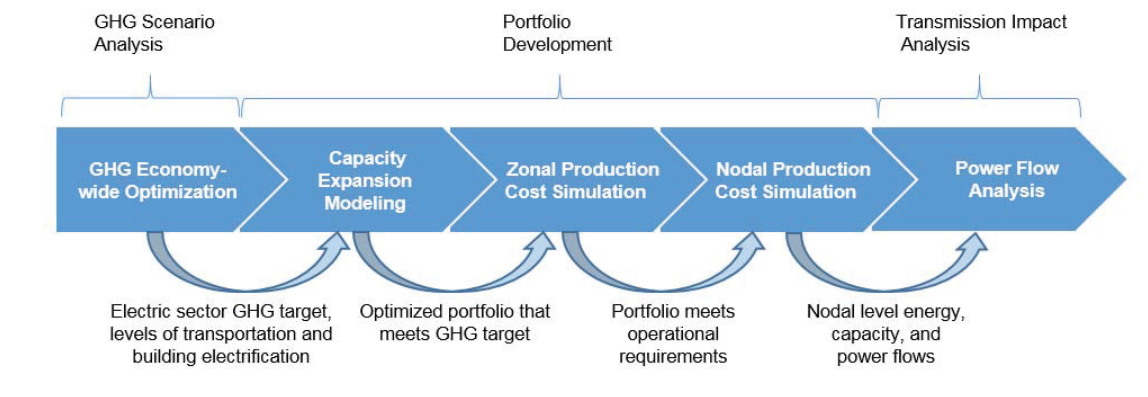
Using the forecasts for SCE bundled load from the Pathway scenario discussed above, SCE then identified the least-cost resource portfolio for its bundled service customers. Because the CAISO operates the system and SCE's resource portfolio is only part of it, and the operational characteristics of the 2030 CAISO system-wide portfolio were studied earlier, SCE did not need to complete an operability study on the bundled portfolio. However, it was necessary to validate that the bundled portfolio meets GHG emissions targets. SCE used the

Commission's Clean Net Short ("CNS") methodology to complete this analysis.[42] The process

for developing the bundled SCE Preferred Portfolio is depicted in Figure II-3 below.

Figure II-3
SCE's IRP Bundled Portfolio Development Process
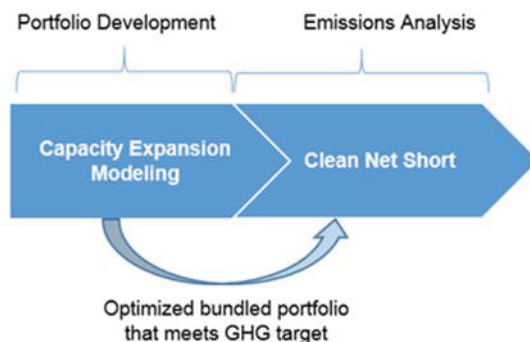
As required by D.18-02-018 and subsequent rulings, SCE also developed a conforming

scenario based on inputs and assumptions used in the Commission's Reference System Plan and

the 2017 IEPR ("Conforming scenario"). These inputs and assumptions include existing

resources, candidate resources, candidate resource costs, fuel costs, GHG allowance costs, load

forecast, and system constraints such as import/export limits. Similar to the process for

developing the SCE Preferred Portfolio, SCE followed the steps in Figure II-3 to develop and

analyze the Conforming scenario, in order to construct the SCE Conforming Portfolio.

A.   **Objectives**

SCE's objectives for its IRP analytical work are consistent with the goals for the IRP

process set forth in SB 350. Namely, SCE's intent was to develop optimized portfolios that

could meet California's goal of reducing economy-wide GHG emissions 40% below 1990 levels

in a cost-effective manner, as well as maintaining reliability and meeting other state goals.[43]

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[42]   As discussed in Section III.B.1.a, SCE made some modifications to the CNS methodology.
[43]   *See* Cal. Pub. Util. Code §§ 454.51(a), 454.52(a)(1).

SCE's objectives in developing the CAISO system-wide SCE Pathway System Plan were to demonstrate that the portfolio could meet operational requirements, e.g., ancillary services and ramping, while meeting the GHG emissions planning target for the CAISO system. In particular, SCE's primary analytical objectives in developing the SCE Pathway System Plan were to:

1.   Achieve a California electric sector 2030 GHG emissions planning target of 28 MMT (approximately 22.4 MMT for the CAISO system)[44] that supports GHG abatement from other sectors of the economy and enables the state to feasibly and cost-effectively meet its 2030 GHG emissions limit of 260 MMT.

2.   Provide sufficient ancillary services to serve load in the CAISO system.

3.   Provide adequate ramping capability to serve net load in the CAISO system.

4.   Avoid over-commitment of system infrastructure and potential system resources by utilizing existing transmission and reducing locational capacity requirements.

5.   Develop lessons learned, suggestions for improvement, or additional requirements for IRP CAISO system-wide modeling to improve its effectiveness.

SCE's analytical objectives in developing the bundled SCE Preferred Portfolio were to:

1.   Achieve a mass-based 2030 GHG emissions planning target for SCE's bundled service customers of 5.1 MMT,[45] which is consistent with the electric sector 2030 GHG emissions planning target of 28 MMT described above.

2.   Limit the selection of shared system resources, such as existing transmission and import and export capability, to SCE's bundled service customers' share of overall system load. This was done to allow SCE's bundled portfolio to use system resources without over-relying on the system to provide ancillary services and ramping capability.

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[44] As the CAISO system represents approximately 80% of the load share of all retail electric providers in the state, the 2030 CAISO system GHG emissions planning target in SCE's Pathway scenario is assumed to be 22.4 MMT of the total electric sector 28 MMT target.

[45] As SCE's system is expected to represent approximately 22.7% of CAISO system load in 2030, SCE's target in this scenario is 5.1 MMT (mathematically, 28 MMT * 80% * 22.7% = 5.1 MMT).

3. Limit SCE's candidate generation resources, as identified in the RESOLVE model, to its bundled load share to prevent over-subscribing the technical potential of economic resources, which helps avoid potential difficulties in combining all LSEs' preferred portfolios into the Commission's Preferred System Plan.

B. Methodology

This section discusses how the SCE Pathway System Plan and the SCE Preferred Portfolio were developed for the CAISO system and SCE bundled service customers, respectively. This section also addresses SCE's methodology for developing the SCE Conforming Portfolio. First, SCE describes the economy-wide GHG scenario analysis it performed to identify the most feasible and economical strategy to achieve 260 MMT of GHG emissions by 2030, including the methodology and results of such analysis. Second, SCE discusses the modeling tools it used for its IRP modeling. Third, SCE addresses its modeling approach for this IRP. Finally, SCE explains the assumptions used in its IRP modeling.

1. GHG Scenario Analysis

As part of its strategic planning activities in the first half of 2017, SCE engaged in economy-wide GHG scenario analysis on how California can meet its 2030 GHG emissions goal at the least cost.[46] SCE leveraged this GHG scenario analysis to arrive at an electric sector GHG emissions planning target of 28 MMT. This target along with other attributes of this scenario such as load forecasts, EV forecasts, and level of building electrification were used to create the SCE Pathway System Plan and SCE Preferred Portfolio for this IRP.

SCE used the Energy+Environmental Economics ("E3") PATHWAYS model[47] and internally-developed economic adoption and renewable optimization models for its GHG scenario analysis. The scenarios that were analyzed include an economy-wide, business-as-usual

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[46] Further details on SCE's GHG scenario analysis are included in Appendix A.
[47] *See* E3, PATHWAYS model, available at: https://www.ethree.com/tools/pathways-model/.

scenario that reflected then current legislative and regulatory policies that impacted GHG emissions ("Current Policy Scenario"). The Current Policy Scenario includes measures and requirements intended to achieve California's 2030 GHG emissions limit of 260 MMT, with 36 MMT of the emission reductions remaining to be incentivized by the cap-and-trade market.[48] SCE analyzed the following three alternative scenarios that abate the incremental 36 MMT of emissions in the Current Policy Scenario and meet the state's 2030 GHG emissions limit:

- Clean Power and Electrification (i.e., the Pathway) – transportation and building electrification along with further decarbonization of the electric sector.

- Renewable Natural Gas – replacement of natural gas with renewable natural gas for all end uses along with electrification of the light-duty vehicle fleet.

- Hydrogen – adoption of hydrogen fuel cell vehicles utilizing hydrogen developed through electrolysis along with further decarbonization of the electric sector.

When developing the three scenarios above, SCE selected specific GHG abatement measures beyond those assumed in the Current Policy Scenario. Specifically for SCE's Pathway, GHG abatement measures were selected based on four key criteria:

- Relative GHG abatement potential as compared with other alternatives;

- Relative marginal abatement cost as compared with other alternatives;

- Feasibility; and

- Consistency with meeting the state's 2050 GHG emissions goal (in particular, SCE looked at technologies that will continue to support GHG emissions reductions beyond 2030 and help California achieve its 2050 goal, i.e., technologies with low risk of stranded investment by 2050).

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[48] CARB recently released its latest California GHG emissions inventory, covering statewide GHG emissions data for 2000-2016. *See* CARB, *California Greenhouse Gas Emission Inventory – 2018 Edition*, July 11, 2018, available at: https://www.arb.ca.gov/cc/inventory/data/data.htm. SCE's GHG scenario analysis was based on the prior California GHG emissions inventory, covering statewide GHG emissions data for 2000-2015, which was the latest data available at the time.

In the development of the Renewable Natural Gas and Hydrogen scenarios, specific assumptions were made about the emergence and significant adoption of a carbon-free fuel (renewable natural gas and hydrogen for these scenarios) and their respective effects on GHG emissions. Then, additional GHG abatement measures for each scenario were selected using the criteria described above to create scenarios that are fully compliant with California's 2030 GHG emissions limit.

In order to compare the scenarios, the incremental abatement costs associated with abating the incremental 36 MMT from the Current Policy Scenario were then calculated for each scenario.[49] These incremental abatement costs were calculated by taking the difference in economy-wide costs between each analyzed scenario and the Current Policy Scenario for the years 2018 through 2030. SCE calculated net present values ("NPVs") of these differences. The NPV cost difference was then divided by the similarly discounted GHG reduction difference.

SCE discusses the Current Policy Scenario, the three alternative scenarios, and the comparative results of the three scenarios in further detail below.

a) **Current Policy Scenario**

In order to develop a baseline, SCE first modeled an economy-wide GHG scenario that included then-current GHG reduction policies and likely adoption of GHG abatement technologies supported by then current policies. This analysis forecasted the resulting statewide GHG emissions under the Current Policy Scenario to be 308 MMT in 2030, approximately 48 MMT higher than California's 260 MMT 2030 GHG emissions limit. SCE then deducted 12 MMT to represent the GHG abatement obligations projected to be met by cap-and-trade offsets

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[49] SCE used marginal abatement costs in determining which GHG abatement measures to include in each scenario and incremental abatement costs in comparing scenarios. The incremental abatement costs represent the average cost of achieving the last 36 MMT of GHG emissions reduction.

(consistent with the offset limit of 6% of covered entities' compliance obligations for 2030).[50]

As shown in Figure II-4 below, this reduced the incremental emissions reductions to be

addressed from 48 MMT to 36 MMT.

Figure II-4
2030 GHG Emissions of SCE's Current Policy Scenario and Incremental GHG
Reductions Needed to Meet State Limit
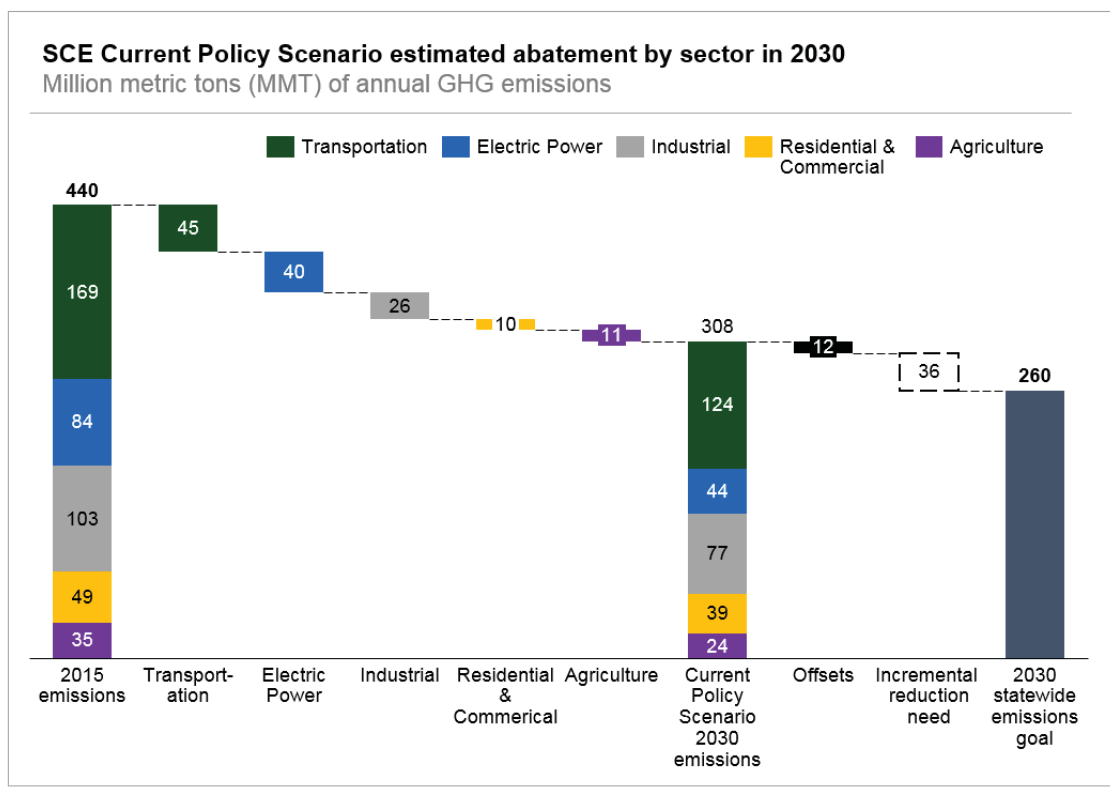
The Current Policy Scenario was also used to derive relative abatement costs and GHG

abatement potential for the available incremental GHG abatement measures.[51]

b)   **SCE's Pathway**

SCE developed the Pathway as an optimized set of measures to achieve California's 2030

GHG emissions limit of 260 MMT at the lowest reasonable cost. SCE's Pathway includes the

following key measures:

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[50]   *See* Cal. Health & Safety Code § 38562(c)(2)(E)(i)(II).
[51]   *See* Appendix B, California GHG Abatement Cost and Opportunity Curve.

- 80% carbon-free electricity in the electric sector;

- Electrification of 6.8 million light-duty, 184,000 medium-duty, and 24,000 heavy-duty vehicles; and

- 30% penetration of electric heat pump space and water heating.

Under the Pathway scenario, the electric sector reduces its GHG emissions to 28 MMT statewide by 2030. As further shown below, SCE's analysis determined that the incremental abatement cost of achieving the last 36 MMT of decarbonization in the California economy is $79 per MT in the Pathway scenario.

c) <u>Other Scenarios</u>

SCE also considered alternate economy-wide scenarios that achieved California's 2030 GHG emissions limit of 260 MMT, relying on alternative energy sources and energy carriers to meet the state's energy needs.

The Renewable Natural Gas scenario relies on significant production of renewable natural gas beyond the feedstock available in the state, necessitating the use of expensive out-of-state feedstock beyond the state's population share of imports. As a result, the incremental abatement cost of this scenario is $139 per MT, almost twice the incremental cost of SCE's Pathway. The Renewable Natural Gas scenario is also less feasible than the Pathway because power-to-gas technology is not yet commercially available.

The Hydrogen scenario relies on a significant adoption of hydrogen light-duty vehicles (4 million by 2030), which would necessitate parallel re-fueling infrastructure to current gas stations to be developed in the next 12 years. It also relies on pre-commercial electricity-to-hydrogen conversion technologies such as electrolysis. As a result, the Hydrogen scenario is less feasible than the Pathway and also the most expensive scenario to meet the state's 2030 GHG emissions limit, at $262 per MT.

d) **Comparison of Scenarios**

In sum, SCE's Pathway is the best strategy for meeting California's 2030 GHG emissions goal. It includes measures to meet the 260 MMT GHG emission target, and of the three alternatives to the Current Policy Scenario considered by SCE, it is the most cost-effective by a wide margin. In addition, SCE's Pathway relies on technologies that are already commercially available, making it the most feasible approach. Figure II-5 below summarizes the results of SCE's GHG scenario analysis for the three alternative scenarios.

Figure II-5
Comparison of Three Alternative Scenarios

	Pathway	Renewable Natural Gas ("RNG")	Hydrogen ("H2")
Carbon-Free Electricity Delivered	80%	60%	80%
Renewable Energy Over-Generation	Managed through up to 10 GW of battery storage	Used to produce synthetic methane through "power to gas"	Used for hydrogen production from steam reforming and electrolysis
Transportation: Light-Duty Passenger Vehicles ("LDVs")	7 million EVs 24% of LDV stock	7 million EVs 24% of LDV stock	2 million EVs 4 million H2 fuel cell vehicles 22% of LDV Stock
	~13% reduction in transportation-related refinery throughout		
Transportation: Medium-Duty ("MDV") and Heavy-Duty ("HDV") Vehicles (Buses and Trucks)	9% MDVs, 6% HDVs are compressed natural gas ("CNG")	12% MDVs, 12% HDVs are CNG	4% HDVs are H2 7% MDVs, 6% HDVs are CNG
	15% MDVs and 6% HDVs are EVs	7% MDVs and 1% HDVs are EVs	
Space and Water Heating (Residential and Commercial buildings)	Up to 30% electrification of space and water heating end uses	42% of natural gas replaced by RNG, 7% of natural gas replaced by H2	Up to 30% electrification of space and water heating end uses
Fuels and Other End Uses	7% of natural gas replaced by RNG		7% of natural gas replaced by H2 (technical limit)
Risks	- Dependent on broad adoption of electrified technologies	- Power to gas not yet commercially available - A large biogas market requires expensive imports	- Most expensive pathway - Requires significant H2 adoption outside CA - Lack of sufficient delivery infrastructure
Average Abatement Cost (180 MMT)	$37/MT	$47/MT	$70/MT
Incremental Abatement Cost (last 36 MMT)	$79/MT	$137/MT	$262/MT

2. **Modeling Tool(s)**

For its IRP modeling, SCE utilized different tools, based on the specific requirements of each process step, in analyzing and validating resource portfolios. The following Figure II-6 provides an overview of different modeling tools that SCE used in the IRP process.

Figure II-6
Modeling Tools Used in SCE's IRP Process

CAISO System-wide Portfolio – SCE Pathway System Plan

Capacity Expansion	Production Cost Simulation (Zonal)	Production Cost Simulation (Nodal)	Power Flow Analysis
▪ Develop the least-cost CAISO system-wide portfolio to serve the load, and meet emissions and Planning Reserve Margin requirements	▪ Evaluate the operational performance of resource plans ▪ Provide emissions intensity and develop the matrix for allocating emissions among LSEs	▪ Generate locational generation schedules and transmission line flows for power flow studies	▪ Perform reliability studies, including new resource interconnection and import/export studies

SCE Bundled Portfolios – SCE Preferred Portfolio and SCE Conforming Portfolio

Capacity Expansion	Clean Net Short
▪ Develop the least-cost bundled portfolio to serve the load, and meet the bundled portfolio emissions requirement	▪ Validate emissions for bundled portfolios using Clean Net Short methodology

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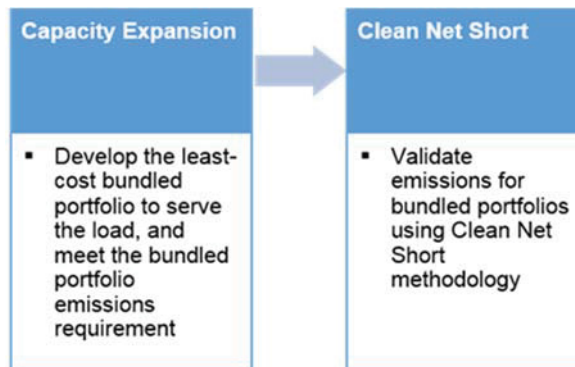
Table II-2 below provides information on specific modeling software used by SCE to develop its IRP.

Table II-2
Modeling Software Specifications

Model Type	Model	Vendor	Version number
Capacity Expansion	ABB CE	ABB	17.4
Production Cost	PLEXOS	Energy Exemplar	7.500 R02
Power Flow	Positive Sequence Load Flow ("PSLF")	General Electric	21.0

a) Capacity Expansion Modeling

Among the modeling tools mentioned above, the capacity expansion model is critical in the IRP process because it is utilized to develop the optimized resource portfolios. SCE used the ABB CE model to develop its resource portfolios to meet GHG emissions and other constraints. ABB CE is a commercially available, long-term resource planning tool developed by ABB Enterprise Software Company. Similar to RESOLVE, ABB CE is capable of optimizing a well-defined power system simulation to meet GHG requirements, transmission and import/export limits, the planning reserve margin, and energy balance requirements at the least cost.

SCE selected ABB CE for the additional functionalities it provides, to support SCE in developing multiple optimal resource portfolios. For example, ABB CE has the ability to consider all studied years instead of relying on the four sample years in RESOLVE. It also models each thermal generating unit individually and is capable of simultaneously co-optimizing the investment, dispatch, and retirement/refurbishment. Additionally, ABB CE directly uses 8,760 hourly load, renewables, and hydropower data, to calculate the "typical week" of each month for optimization.

In general, the ABB CE resource buildouts are more diverse, including more wind and geothermal resources, than RESOLVE's portfolios. They are also consistently more economical

than the comparable RESOLVE buildouts using the same resource price per kilowatt-year.[52] Further, validation of the CAISO system-wide ABB CE resource portfolio using production cost simulations demonstrates that the portfolio is operationally feasible to meet demand and ancillary service requirements. The CNS Calculator computations demonstrate that the ABB CE-derived portfolios satisfy GHG emissions constraints.

Table II-3 provides a summary of differences between the ABB CE model and RESOLVE and an explanation of how those differences should be considered during evaluation of SCE's portfolios.

Table II-3
Differences between RESOLVE and ABB CE Models

RESOLVE	ABB CE	How differences should be considered during evaluation of portfolios
Aggregated super thermal generators	Detailed individual generator modeling	ABB CE enables a more detailed thermal supply stack representation by modeling each thermal generator individually. The result is a more realistic estimate of fuel use and GHG emissions.
Includes ancillary service requirements	Does not include ancillary service requirements	Ancillary service requirements, as operational reliability requirements, are better evaluated in production cost simulation modeling where detailed generator characteristics and 8,760 hourly demand is evaluated. SCE evaluates these requirements in PLEXOS production cost simulation modeling.

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[52] For example, the ABB model is capable of better optimizing storage and other resource dispatch than the RESOLVE model. This further minimizes the required portfolio buildout to achieve a given GHG emissions goal.

Investment decisions on: • New generation (gas and renewables) • New storage • New demand response	Investment decisions on: • New generation (gas and renewables) • New storage • Generation retirement • Generation refurbishments • Purchase and sale power contracts • Demand-side management programs • New transmission • Cap-and-trade emission allowance transactions • Fuel purchases	ABB has additional functionality when considering investment decisions. Although SCE did not use these functionalities in this IRP, the additional functionality makes ABB a more integrated model that would help the Commission achieve its goals for the IRP process if it were adopted as the IRP's primary modeling tool for future cycles.
For each year in the analysis horizon, RESOLVE models operations for 37 independent days	For each year in the analysis horizon, ABB CE model applies the "typical week" method to scale down the number of hours	ABB CE provides a better representation of electrical load because there is greater variability from its "typical week" sampling method compared to RESOLVE's 37 days. "Typical week" sampling results in 84 types of days (one week for each month of 7*12 days) – more than twice as many as RESOLVE. Some months in RESOLVE have only one type of day associated, leaving no room for even a weekday-weekend differentiator in all months.
Correlated 37 shapes for load, renewables, and hydropower	Independent 8,760 shapes for load, renewables, and hydropower	Loads between the two models should be considered completely comparable because SCE translated the RESOLVE 37 load, renewables, and hydropower shapes into 8,760 hourly shapes before populating ABB CE.
RESOLVE results as viewed in Dispatch Viewer show daily storage efficiencies around 50% even though the storage characteristic data in User Interface indicated 85%	ABB CE operational results show that storage efficiency is maintained as specified in the input data	RESOLVE may build more renewable or storage resources than necessary because the storage is operating at lower efficiency than specified. Energy charged in batteries goes to waste, requiring additional thermal operations.

Aggregated hydropower with daily energy limit corresponding to 37 days	Allows individual hydropower modeling as either baseload, peak shaving, or limited energy. Both or either or daily or monthly energy limits are available.	SCE converted the RESOLVE daily energy limit into a monthly energy limit in ABB CE. The annual hydropower generation between RESOLVE and ABB CE are consistent.
Financial model minimizes NPV of all-in resource cost	Financial model minimizes resources' Real Economic Carrying Charge	ABB CE has a comparable financial valuation method to RESOLVE. ABB CE values costs based on the difference of NPVs from purchasing resources in perpetuity when resource life is longer than 2030. Similarly, RESOLVE calculates an additional weight on the NPVs incurred in 2030.

b) <u>Production Cost Simulation Modeling</u>

In the IRP process, it is important to conduct production cost simulations to validate the operational feasibility and performance of the portfolios built by the capacity expansion model for the CAISO system. Production cost simulation is used to dispatch generation resources at the least cost to meet the demand and ancillary service requirements of the system on an hourly basis, while satisfying all the generator operational constraints, transmission constraints, and other system reliability requirements. Ancillary services, such as operating reserves and frequency response, are necessary tools managed by the CAISO to ensure operational reliability and stability of the power system. Compared to the capacity expansion model, the production cost simulation model, which considers the detailed generator characteristics, ramping capabilities and balancing load on an hourly basis, is a better tool to assess the operational feasibility of resource portfolios in a power system.

SCE used PLEXOS, a commercial software program with a mixed integer programming optimization engine, to perform the production cost simulations for the system and mimic the CAISO day-ahead market operations. PLEXOS co-optimizes energy and ancillary services, and generates the commitment and dispatch of available generation resources to meet demand and

reserve requirements at the least cost, subject to transmission and individual generation resource constraints. SCE's PLEXOS model is a CAISO-only, zonal/nodal model based on the full network model CAISO publishes on a regular basis.

c) Transmission Impact Analysis

In order to fully evaluate a CAISO-wide system resource portfolio and its impact on the electric system, it is necessary to supplement the above-described capacity expansion modeling and production cost simulation modeling with detailed power flow analysis. The RESOLVE model is an Excel-based model designed to co-optimize investment and dispatches to identify least-cost portfolios for system goals; however, it is not truly capable of modeling the impact of resource portfolios on the transmission system. General Electric's PSLF software version 21.0 was used to perform power flow analyses to examine the SCE Pathway System Plan's performance impacts on SCE's transmission system and on SCE's transmission intertie lines. PSLF is a software package of programs for studying system transmission networks and equipment performance in both steady-state and dynamic environments. Specifically, PSLF was used to investigate SCE's maximum export hour and the integration of incremental renewables located within SCE's transmission planning area.

3. Modeling Approach

Figure II-2 and Figure II-3 provide a general overview of how SCE developed its CAISO system-wide SCE Pathway System Plan and its bundled SCE Preferred and Conforming Portfolios. This section describes SCE's modeling approach in more detail.

a) CAISO System-wide Portfolio Development

SCE employed an iterative process to develop its SCE Pathway System Plan. The first step was to develop scenario inputs, such as demand and DER forecasts, GHG emissions targets, required planning reserve margin, and other inputs for the Pathway scenario. As shown in Table II-5 in Section II.B.4, SCE adjusted some of the inputs provided in the Commission's Reference

System Plan and the 2017 IEPR to reflect SCE's previously developed Pathway approach. For both its CAISO system-wide portfolio and SCE bundled portfolio development, SCE utilized mass-based GHG emissions constraints rather than the GHG Planning Price.[53] SCE also used a straight-line approach to apply declining GHG emissions planning targets as yearly constraints.

Second, SCE utilized a capacity expansion model to build the least-cost resource portfolio satisfying the chosen constraints. Third, once the resource portfolio was determined by the capacity expansion model, SCE used the PLEXOS production cost simulation model to evaluate the power system's operational performance. This step of the analysis used more detailed generator characteristics, operating constraints, transmission constraints, and ancillary service requirements. Fourth, the Commission's CNS Calculator, as modified to reflect estimated SCE Pathway System Plan emissions, was used to validate total GHG emissions from the proposed resource portfolio. Finally, once the portfolio was validated to meet operational and GHG emissions constraints, a power flow simulation tool determined if SCE's transmission system can reliably integrate the incremental resources. The result of this process is the SCE Pathway System Plan.

b) <u>Bundled Portfolio Development</u>

SCE utilized the ABB CE model to develop the least-cost resource portfolios that meet its relevant GHG emissions targets for bundled service customers. The modeling approach represented the system as three linked transmission areas: SCE bundled, the remainder of CAISO, and the rest of the Western Electricity Coordinating Council ("WECC"). This was done for two reasons: (1) to ensure that shared resources (e.g., CAISO system resources, major transmission lines, and import/export lines) are not excessively used by any one LSE; and (2) to

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[53] The Commission's electric sector GHG emissions planning target is mass-based. Moreover, for their bundled portfolios, the Commission gave LSEs the option to use either the GHG Planning Price or their mass-based GHG emissions benchmark. *See* D.18-02-018 at 124.

more precisely account for GHG emissions attributable to SCE bundled service customers.[54]

Figure II-7 below depicts the regional structure of the SCE bundled system.

Figure II-7
SCE Bundled System Topology

GHG Constraint on SCE
Bundled Portfolio
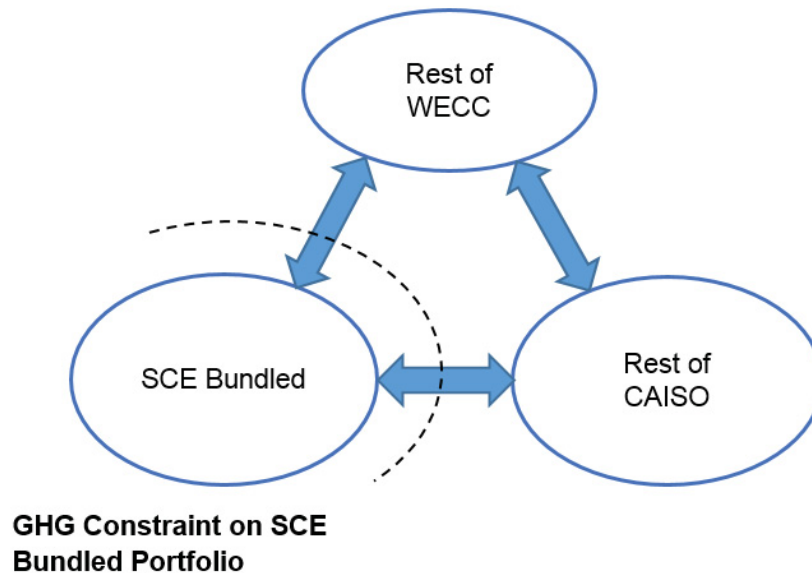
To constrain resource sharing between the three regions, transmission limits were estimated based on both the load share and the physical, simultaneous transmission limits. The following Table II-4 summarizes the interregional transmission limits enforced in the SCE bundled system.

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[54] SCE does not enforce the 15% planning reserve margin in development of its bundled portfolios but relies on the system to provide sufficient capacity to procure and meet SCE's Resource Adequacy ("RA") requirements on an annual basis. Production cost simulation is not needed for bundled portfolios because each LSE relies on system resources and resources from other LSEs, and it is not economic to require resource self-sufficiency for each LSE. There was also no need to do transmission impact analysis on the bundled portfolios because SCE's resource portfolio is part of the system.

Table II-4
Interregional Transmission Limits

Transmission Lines	Power Flow Limit Source	Preferred Amount in 2030 MW	Conforming Amount in 2030 MW
Rest of WECC to SCE Bundled	SCE bundled load share of CAISO import limit	2,282	2,672
Rest of WECC to Rest of CAISO	Rest of CAISO load share of CAISO import limit	7,786	7,396
SCE Bundled to Rest of CAISO	Path 26 South to North transmission limit	3,000	3,000
Rest of CAISO to SCE Bundled	Path 26 North to South transmission limit	4,000	4,000

Consistent with the Commission's assumption, a deemed GHG emissions rate of 0.428 MT CO2e per megawatt-hour ("MWh") was applied to the rest of WECC and the rest of CAISO so that there would not be a GHG emissions advantage for imported power over generation within SCE's bundled region.[55]

For the SCE resources subject to the cost allocation mechanism ("CAM"), the resource share that contributes to SCE's bundled portfolios is equal to the ratio of annual SCE bundled load and annual SCE service area retail sales.

For the non-CAM SCE resources, SCE used different approaches in creating the bundled portfolios for its Pathway scenario and the Conforming scenario. Specifically, in developing SCE's bundled portfolio for the Pathway scenario, SCE applied the IOUs' proposed GAM/PMM proposal for replacing the PCIA methodology, and based the allocation on the ratio of forecast annual CCA departing load share to the total forecast bundled load and CCA departing load.[56] For the bundled portfolio in the Conforming scenario, 100% of the capacity of the non-CAM resources were allocated to serve SCE's bundled service customers, consistent with the current PCIA methodology.

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[55] *See* RESOLVE_User_Interface 2017-09-07.xlsm, "SYS_Regional_Settings" tab.
[56] *See* Appendix C, GAM/PMM Portfolio Treatment.

When considering candidate resources for its bundled portfolios, SCE partitioned the candidate resources on a pro rata basis, according to the SCE bundled load share to the CAISO system load in 2030. If this candidate resource partitioning approach is used by all LSEs, it will ensure that the total selected resources by each category will not exceed the maximum available potential when the Commission combines LSEs' IRPs in forming the Preferred System Plan.

Additionally, in developing the SCE Preferred Portfolio, SCE did not assume that all RPS resources with expiring contracts were automatically re-contracted. The ABB CE model determined whether or not such resources would be selected in the optimization process.

Lastly, as in the CAISO system-wide portfolio development, SCE used the CNS Calculator to validate total GHG emissions from the proposed bundled resource portfolios.

c)   **Transmission Impact Analysis**

SCE used PSLF software to model the SCE Pathway System Plan's renewable capacity additions located within SCE's transmission planning area, and to perform limited power flow analyses for the purposes of verifying the reliability of this resource portfolio and reducing resource integration costs where possible.

Individual cases were created for four SCE transmission zones. If the power flow analysis identified transmission upgrades due to thermal overloads and voltage violations resulting from the incremental renewables, the analysis then explored relocating the renewables to avoid triggering those identified transmission upgrades.

In addition, SCE evaluated the impact of the SCE Pathway System Plan on SCE's transmission intertie lines as a result of exporting the surplus energy generated by the incremental renewables. This is performed by modeling the maximum export hour in PSLF based on the generation dispatch schedules and transmission line flows from the PLEXOS nodal production cost simulation.

4. Assumptions

The planning assumptions associated with SCE's Pathway scenario align with those developed in SCE's prior economy-wide GHG scenario analysis as discussed in Section II.B.1. The Pathway's electric sector GHG emissions in 2030 are 28 MMT. SCE used this value to define the electric sector GHG emissions planning target in the Pathway scenario. However, as referenced in Section II.B.1, simultaneous GHG abatement actions are required in the transportation and building sectors for the 28 MMT electric sector planning target to be valid.

For load and DER assumptions, SCE leveraged its latest retail sales forecast (referred to as SCE's 2017 Internal Forecast),[57] adjusting for building electrification and energy efficiency. For energy efficiency, SCE reflected SB 350 goals by incorporating the CEC's 2017 IEPR-estimated SB 350 energy efficiency impact (or the CEC's 2017 IEPR "High_Plus_AAEE" scenario forecast).[58] SCE derived its building electrification load assumption from its economy-wide GHG scenario analysis. Supply-side resource costs, performance characteristics, and resource potential were extracted from the assumptions embedded in the RESOLVE model used to develop the Commission's Reference System Plan.

For natural gas price assumptions, SCE leveraged its January 2018 proprietary gas price forecast. In the near term, SCE's gas price forecast is substantially lower than the 2017 IEPR gas forecast. However, by 2030, the SCE proprietary gas price forecast and the Reference System Plan forecast converge. SCE made this adjustment in order to better reflect current market conditions, resulting in more economic resource portfolios.

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[57] SCE's 2017 Internal Forecast assumptions generally align with the Pathway's expected adoption of EVs and BTM PV.

[58] Efficiency impacts in the baseline forecast, or "committed" savings, are reflected in the baseline forecast. Expected efficiency impacts beyond 2017 are incorporated in the managed forecast through additional achievable energy efficiency ("AAEE") savings.

The assumptions used in SCE's Conforming scenario are consistent with the direction provided by the Commission. 2017 IEPR mid-load assumptions and shapes were used and RESOLVE's embedded supply-side assumptions were applied.

The following Table II-5 includes a side-by-side comparison of assumptions that differ in the Pathway and Conforming scenarios, including the rationale for such differences. For the most part, the assumptions are at the CAISO system level, although some assumptions are specific to the development of SCE's bundled portfolios.

Table II-5
Key Assumption Deviations Between the Pathway and Conforming Scenarios

	Pathway CAISO System Forecast in 2030	Conforming CAISO System Forecast in 2030	Rationale
Load Assumptions			
CAISO System-wide Electricity Demand	2017 SCE Internal Baseline System-wide Consumption Forecast 250,553 GWh	2017 IEPR Mid Baseline 267,506 GWh	Accounts for changes in electric load due to additional GHG abatement measures assumed in the Pathway scenario.
CCA Departure (SCE Bundled)	2017 Internal Forecast 18,482 GWh	Modified 2017 IEPR Mid Baseline 14,227 GWh	IEPR forecast modified by SCE's internal forecast of CCA load departure.
LDV Electrification	2017 SCE Internal Forecast 23,042 GWh	2017 IEPR Mid Baseline 11,261 GWh	Based on Pathway goal that 6.8 million LDVs are EVs statewide by 2030.
MDV Electrification	2014 ICF and E3 TEA Study[59] 974 GWh	N/A	Based on Pathway goal that 183,700 MDVs are EVs statewide by 2030.
HDV Electrification	2014 ICF and E3 TEA Study 416 GWh	N/A	Based on Pathway goal that 23,500 HDVs are EVs statewide by 2030.
Off-Road Transportation Electrification	2014 ICF and E3 TEA Study 2,619 GWh	2017 IEPR Mid Baseline 683 GWh	SCE's off-road transportation electrification forecast accounts for additional equipment.

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[59] *See* ICF International and E3, *California Transportation Electrification Assessment, Phase 1: Final Report*, August 2014, updated September 2014, available at: http://www.caletc.com/wp-content/uploads/2016/08/CalETC_TEA_Phase_1-FINAL_Updated_092014.pdf.

Building Electrification	PATHWAYS Derived 4,630 GWh	2017 IEPR Mid Baseline 0 GWh	Based on SCE's PATHWAYS GHG scenario analysis output.
BTM PV	2017 SCE Internal Forecast 36,534 GWh	2017 IEPR Mid Baseline Mid AAPV 33,635 GWh	SCE utilizes its own generalized bass diffusion model for more recent PV adoption data, and incorporates its best internal view on future zero net energy compliance impact on PV installations.
Non-PV Self-Generation	2017 SCE Internal Forecast 15,828 GWh	2017 IEPR Mid Baseline 15,181 GWh	SCE utilizes its non-PV self-generation recent years' growth to forecast future growth.
Energy Efficiency (Incremental Savings)	2017 IEPR High Plus AAEE 41,315 GWh	2017 IEPR Mid Baseline Mid AAEE 28,191 GWh	Modeled the CEC's 2017 interpretation of SB 350 requirements.
Load Shapes	2017 SCE Internal Forecast Load and DER hourly shapes	2017 IEPR Mid Baseline and DER hourly shapes	SCE's 2017 Internal Forecast reflects SCE's view on future load and DER hourly shapes. SCE's load shapes are developed using hourly regression models that incorporate SCE specific historical load, weather, and other variables. SCE also develops its own load shapes for CCAs using the most recent smart meter data for CCAs. The CEC does not have CCA load shapes established.
Electric Sector GHG Emissions Target			
MMT Statewide	28	42	Derived from SCE's PATHWAYS GHG scenario analysis and reflected in SCE's Pathway results.
Other Assumptions and Inputs			
Gas Prices	SCE's proprietary January 2018 Gas Price Forecast	2017 IEPR, updated in April 2018	Better reflects current observed market conditions.
GHG Prices	SCE's proprietary January 2018 GHG Allowance Auction Price Forecast	2017 IEPR, updated in April 2018	Cap-and-trade program tightening is expected to bring auction clearing prices above the floor.
Baseline Resources	Modeled individual thermal generators from RESOLVE, and included OTC replacement	Modeled aggregated natural gas units. Does not include OTC replacement units.	At least five OTC replacement units had empty heat rate data in RESOLVE, resulting in them being excluded from the RESOLVE aggregated natural gas units.

	units.		
Assumptions for Other LSEs' Procurement Activities	Other LSEs procure in a manner consistent with SCE Pathway System Plan	Other LSEs procure in a manner consistent with the Reference System Plan	Illustrates a system plan consistent with SCE's Pathway.
Effective Load Carrying Capability ("ELCC")	Capacity factor of a given resource during RESOLVE's annual peak hour.	ELCC values determined by level of resource (i.e., diminishes as resources are added).	ABB CE accepts one unique capacity factor per resource.
Resource Allocation for Departing Load	Joint IOU GAM/PMM proposal in R.17-06-026	Current PCIA methodology	Pathway scenario consistent with IOU proposal. In Conforming scenario, used PCIA methodology consistent with current Commission decisions.
GHG Intensity Used in CNS Calculator	GHG emissions intensities based on production cost simulation.	Default GHG emissions intensities provided by Commission.	Commission's CNS Calculator did not include GHG emissions intensities for 28 MMT case.

III.

STUDY RESULTS

A. Portfolio Results

1. Portfolio Results for Preferred and Conforming Portfolios

The sections below describe: (1) the SCE Pathway System Plan, SCE's CAISO system-wide portfolio based on SCE's Pathway scenario; (2) the SCE Preferred Portfolio, SCE's bundled portfolio based on its Pathway scenario; and (3) the SCE Conforming Portfolio, SCE's bundled portfolio based on its Conforming scenario. The new and existing resources in the portfolios are itemized in the Commission's data templates.[60]

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[60] *See* Appendix D.1, New Resource Data Template – SCE Pathway System Plan; Appendix D.2, New Resource Data Template – SCE Preferred Portfolio; Appendix D.3, New Resource Data Template – SCE Conforming Portfolio; Appendix E.1, Baseline Resource Data Template – SCE Preferred Portfolio; and Appendix E.2, Baseline Resource Data Template – SCE Conforming Portfolio.

a) SCE Pathway System Plan

The resource additions in the SCE Pathway System Plan are shown in Figure III-8 below. The SCE Pathway System Plan was developed to meet a more stringent GHG emissions planning target (22.4 MMT by 2030) in accordance with the CAISO system share of the Pathway scenario's electric sector 28 MMT target.

There are two distinct periods of resource additions corresponding to the years 2022 to 2024, and 2026 to 2030. Resource additions occurring in the first period (2022-2024), rather than later, are driven by economic factors. In the second period (2026-2030), the primary driver for the selection of additional clean and storage resources is meeting a straight-line decreasing GHG emissions planning target. In 2027, all candidate wind and geothermal resources that did not require transmission upgrades will be exhausted, essentially limiting the capacity expansion model to selecting incremental solar and storage resources to meet the GHG emissions planning targets for the remainder of the planning period. Thus, in 2028 and beyond, only solar and energy storage resources are added.

Figure III-8
SCE Pathway System Plan (CAISO-wide) Annual Modeled Capacity Expansion by
Technology

SCE Pathway System Plan (CAISO-wide) Capacity Additions
MW, cumulative

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy storage	-	-	-	-	-	-	-	-	-	26	3,031	6,261	9,604
Solar	-	-	-	-	318	318	5,634	5,634	5,634	6,793	7,984	9,229	10,735
Wind	-	-	-	-	-	1,648	1,648	1,648	2,833	3,590	3,590	3,590	3,590
Geothermal	-	-	-	-	-	-	-	-	1,463	1,719	1,719	1,719	1,719
Total Renewables	-	-	-	-	*318*	*1,966*	*7,282*	*7,282*	*9,930*	*12,102*	*13,293*	*14,538*	*16,044*
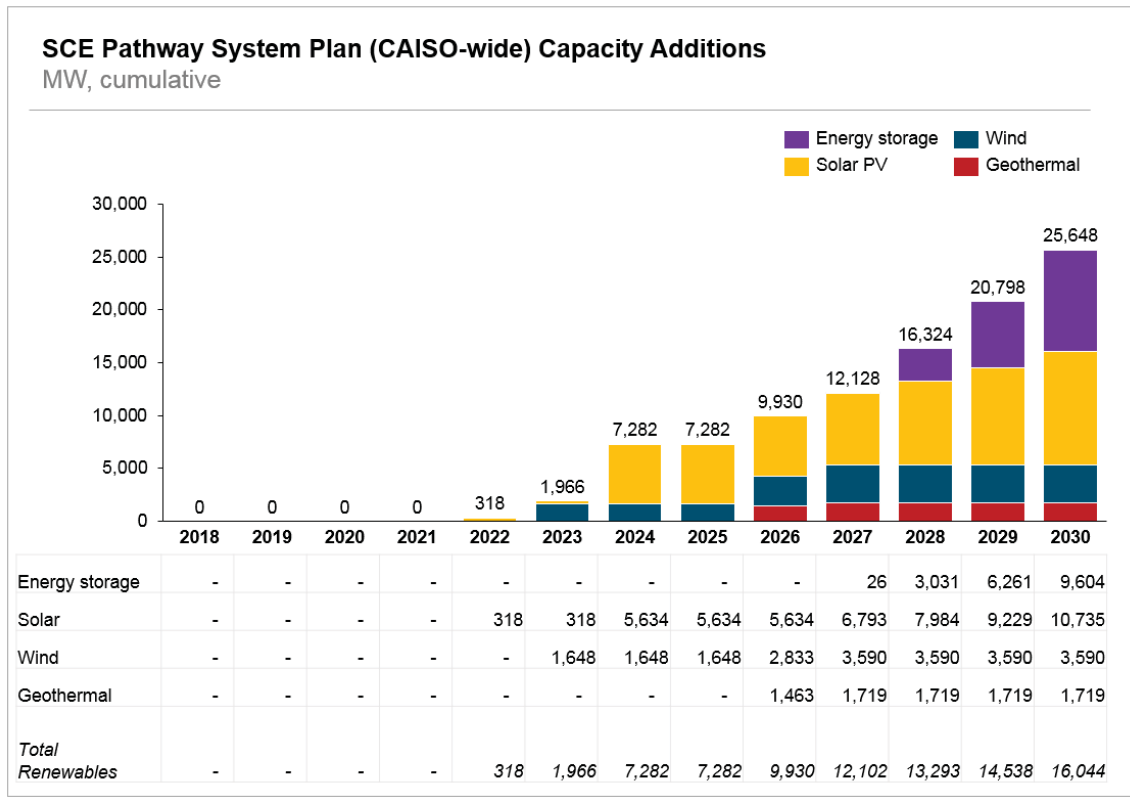
b)   SCE Preferred Portfolio

The resource additions in the SCE Preferred Portfolio are shown in Figure III-9 below.
Similar to buildout of the SCE Pathway System Plan, the SCE Preferred Portfolio was developed
to meet a more stringent GHG emissions constraint (5.1 MMT by 2030) in accordance with the
SCE bundled share of the Pathway scenario's electric sector 28 MMT target. Another key
assumption in developing this portfolio is that the current PCIA methodology will be replaced
with the IOUs' GAM/PMM proposal. Consequently, significant existing SCE portfolio capacity
is assumed to depart with CCA load during the planning period, resulting in more resource
additions in the SCE Preferred Portfolio for remaining bundled service customers than if the
current PCIA methodology remains in place.

The SCE Preferred Portfolio resource additions can be divided into two distinct periods as well, 2022 to 2024 and 2025 to 2030. The timing of resource additions in the first period (2022–2024) are driven by economics. In the second period (2025-2030), resources are selected to meet GHG emissions constraints as the declining emissions target becomes binding.

Figure III-9
SCE Preferred Portfolio (Bundled) Annual Modeled Capacity Expansion by Technology[61]

SCE Preferred Portfolio (Bundled) Capacity Additions
MW, cumulative

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy Storage	-	-	-	-	-	-	-	-	-	-	-	885	1,586
Solar	-	-	-	-	764	764	1,564	1,564	1,564	1,564	1,564	1,762	2,036
Wind	-	-	-	-	-	654	654	654	654	654	1,203	1,321	1,321
Geothermal	-	-	-	-	-	-	-	46	273	643	748	748	887
Total Renewables	-	-	-	-	764	1,417	2,218	2,264	2,491	2,861	3,516	3,831	4,244
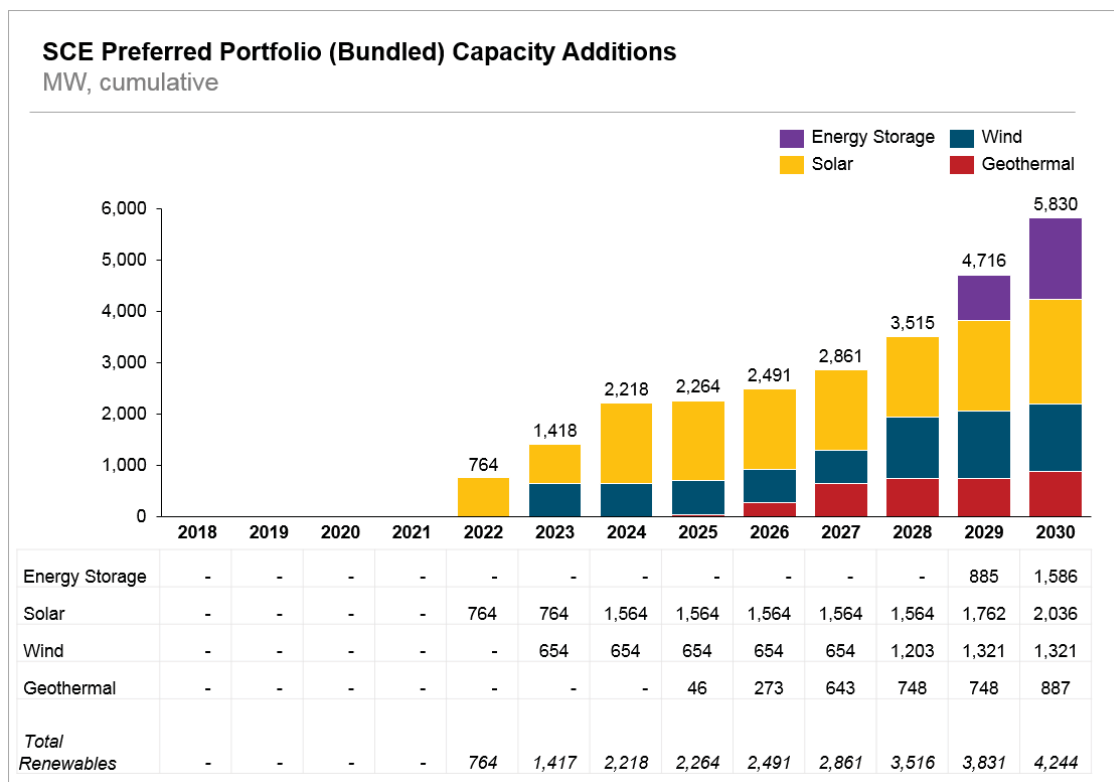
The SCE Preferred Portfolio resource additions (including new resources and existing renewable resources with expiring contracts that were selected by the model) exceed what is required for the CAISO system as a whole in 2022, and for certain resource types in other years. There are two factors driving this outcome.

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[61] In developing the SCE Preferred Portfolio, SCE did not assume that all RPS resources with expiring contracts were automatically re-contracted. The ABB CE model determined whether or not such resources would be selected in the optimization process. The SCE Preferred Portfolio capacity additions include 987 MW of existing wind and geothermal resources with expiring contracts that were selected in the optimization process by 2030.

First, the CAISO system capacity expansion and SCE bundled portfolio capacity expansion are evaluated in separate optimization processes. Building SCE's bundled portfolio becomes a sub-optimization problem, where the solution for individual sub-systems (e.g., the SCE bundled portfolio) may not add up to the solution for the whole system (e.g., the CAISO system-wide portfolio).

Second, the SCE Preferred Portfolio includes more incremental renewables earlier in the planning period for economic reasons, as a result of unique characteristics of SCE's net bundled service customer load. In particular, SCE's net bundled service customer load shapes include a more severe evening ramp to higher relative load levels (partially attributable to electrification load) than the CAISO typical shape. As a result, the "price to beat" of other resources the system could dispatch to meet this load is higher for SCE than in other parts of the CAISO system. Two outcomes of this situation are possible – SCE can either depend on the rest of CAISO system to provide necessary resources or it can build new capacity that is economically competitive relative to the system power available. Without additional constraints, SCE's sub-system would depend on other CAISO system resources. However, as addressed in Section II.B.3.b, SCE enforced additional constraints to limit the amount of "imports" from other parts of the CAISO or WECC that would have to be depended upon to provide for SCE bundled load. Enforcing this constraint, combined with higher cost alternative resources, leads the capacity expansion model to select more incremental renewables earlier in the planning period for the SCE Preferred Portfolio.

c) <u>SCE Conforming Portfolio</u>

The SCE Conforming Portfolio was developed to meet SCE's Commission-established 2030 GHG emissions benchmark of 9.397 MMT.[62] The capacity expansion modeling shows that no resource additions are required in the planning period to meet that constraint. In accordance

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[62] *See Administrative Law Judge's Ruling Finalizing Load Forecasts and Greenhouse Gas Benchmarks for Individual Integrated Resource Plan Filings*, R.16-02-007, June 18, 2018, at 4.

with current Commission decisions, the SCE Conforming Portfolio assumes the PCIA methodology remains in place. As such, as load departs to CCAs, SCE's existing resource portfolio continues to serve SCE's remaining bundled service customers. This means that SCE will be able to meet its GHG emissions targets while serving its bundled load with existing and planned contracts.

SCE also conducted a sensitivity on the SCE Conforming Portfolio that shows the modeled capacity additions required if the IOUs' GAM/PMM proposal is adopted. This sensitivity shows a resource need, amounting to approximately 1.6 GW by 2030. Using the Commission's capacity cost, performance, and other financial assumptions, just under 1.2 GW of this capacity is modeled to come online by the end of 2022. These modeled capacity additions may need to be re-evaluated based on the final outcome of PCIA reform.

d)   **Transmission Impact Analysis Results**

To perform the transmission impact analysis on the SCE Pathway System Plan, SCE used PSLF power flow base cases previously developed for the annual CAISO TPP that represented the year 2027 on-peak load forecast. This is a 1-in-10 year heat wave load level for SCE's service area. Power flow base cases were created for SCE's Kramer_Inyokern, Mountain_Pass Eldorado, Riverside_East Palm_Springs, and Tehachapi transmission zones.

Using the full capacity deliverability status ("FCDS") capacity values from RESOLVE[63] and the Renewable Energy Transmission Initiative ("RETI") 2.0 *Transmission Capability and Requirements Report*[64] as guides, the incremental renewable resources for the SCE Pathway System Plan were strategically placed within SCE's four transmission zones in such a manner as to stay within normal continuous facility thermal ratings, and within minimum and maximum

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[63]   *See* RESOLVE_User_Interface 2017-09-07.xlsm, "REN_Tx_Costs" tab.
[64]   *See* RETI 2.0, *Transmission Capability and Requirements Report*, October 24, 2016, at 3, available at: https://efiling.energy.ca.gov/getdocument.aspx?tn=214168.

voltage levels as dictated by the CAISO Planning Standards.[65] Although the limited power flow analyses did not consider Category P1-P7[66] contingency outages, an attempt was made to place the capacity in such amounts that would allow the use of Remedial Action Schemes ("RAS") to curtail generation to mitigate thermal, post transient, and transient stability issues that could arise due to the addition of these new resources.[67]

Results of the analyses were consistent with the RETI 2.0 *Transmission Capability and Requirements Report*, which stated that capacity estimates for FCDS and energy-only ("EO") interconnections are not additive.[68] When resource capacity placement exceeded the RESOLVE FCDS capacity amounts, base case overloads were observed in most of the four SCE transmission zones. The resource capacity placements were then optimized to fully utilize the FCDS capacity estimates first, with the balance of the resource portfolio capacity additions placed to minimize base case thermal overloads and resource integration costs.

Strategic capacity placement within each SCE transmission zone is necessary to stay within FCDS capacity estimate limits and avoid sub-area capacity constraints. Therefore, resource capacity was placed downstream of known transmission constraint areas, and in areas where generation retirements have occurred. Table III-6 below depicts the placement of capacity additions under the SCE Pathway System Plan in each SCE transmission zone.

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[65] *See* CAISO, *California ISO Planning Standards*, November 2, 2017, available at: http://www.caiso.com/Documents/ISOPlanningStandards-November22017.pdf.

[66] Category P1-P7 contingencies are defined in Table 1 of North American Reliability Corporation reliability standard TPL-001-4, available at: https://www.nerc.com/pa/stand/Pages/ReliabilityStandardsUnitedStates.aspx?jurisdiction=United%20States.

[67] The CAISO Planning Standards limit RAS tripping to 1,150 MW for single contingencies and 1,400 MW for double contingencies. *See* CAISO, *California ISO Planning Standards*, November 2, 2017, at 11, available at: http://www.caiso.com/Documents/ISOPlanningStandards-November22017.pdf.

[68] *See* RETI 2.0, *Transmission Capability and Requirements Report*, October 24, 2016, at 53, available at: https://efiling.energy.ca.gov/getdocument.aspx?tn=214168.

Table III-6
SCE Pathway System Plan Capacity Placement[69]

SCE Transmission Zone	Bus	Voltage	MW
Kramer_Inyokern	Calcite	220 kV	60
	Coolwater	220 kV	482
	Coolwater	115 kV	144
	Victor	220 kV	105
	Victor	115 kV	185
Riverside_East_Palm_Springs	Colorado River	500 kV	621
	Colorado River	220 kV	1,500
	Devers	220 kV	500
	El Casco	220 kV	300
	Red Bluff	220 kV	1,700
Mountain_Pass_Eldorado	Eldorado	500 kV	544
	Eldorado	220 kV	256
Tehachapi	Antelope	500 kV	241
	Antelope	220 KV	500
	Antelope	66 kV	92
	Highwind	220 kV	338
	Whirlwind	500 kV	325
	Whirlwind	500 kV	1,500
	Windhub	500 kV	290
	Windhub	220 kV	1,258
	Windhub	66 kV	68
		Total MW =	11,009

The analyses demonstrated that the SCE Pathway System Plan resource additions in SCE's transmission planning area can be accomplished with little to no transmission network upgrade costs. However, it may be challenging for the existing generation interconnection process to accomplish this strategic placement of resources due to generation cluster study right-sizing, land acquisition, and environmental constraints. SCE will initiate discussions with stakeholders, such as the CAISO, to determine if the generation interconnection and resource procurement processes can be modified to remove these constraints and minimize the cost impact to procure and interconnect the additional renewable resources.

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[69] Of the 25,648 MW total modeled capacity expansion identified in Figure III-8, 9,604 MW are batteries, and the remainder are renewables. 2,000 MW of these renewables are located outside the CAISO system; 3,036 MW are located in Pacific Gas and Electric Company's ("PG&E") or SDG&E's transmission areas; and the remaining 11,009 MW are located in SCE transmission areas.

In addition, SCE used General Electric's PSLF software to assess the impact of SCE Pathway System Plan resource additions on SCE's intertie transmission lines as a result of exporting the surplus energy generated by the incremental renewables. The PLEXOS analysis indicated that the maximum export amount occurred during spring conditions. The power flow analysis of the SCE Pathway System Plan did not find any significant overloads or stability issues that required additional transmission upgrades. Overloads were mitigated through RAS and/or energy storage added in the SCE Pathway System Plan. It should be noted that this export analysis hinges upon the precise placement and amount of incremental renewables in the SCE Pathway System Plan, as identified above. Any deviation from the placement of incremental renewables may necessitate upgrades, additional energy storage, or protection schemes to mitigate local area or export issues.

e) <u>**Consistency with Statutory IRP Goals and Other Statutory Requirements**</u>

Both the SCE Preferred Portfolio and the SCE Conforming Portfolio are consistent with the statutory IRP goals set forth in Public Utilities Code Section 454.52(a)(1) as discussed below.

Meeting the GHG emissions reduction targets established by CARB, in coordination with the Commission and CEC (Section 454.52(a)(1)(A)). As further explained in Sections III.B.1.a and III.C.1, both the SCE Preferred and Conforming Portfolios result in 2030 GHG emissions below SCE's Commission-established 2030 GHG emissions benchmark of 9.397 MMT, as evaluated in the CNS Calculator. The SCE Preferred Portfolio has a 2030 GHG emissions level of 4.8 MMT and the SCE Conforming Portfolio has a 2030 GHG emissions level of 7.5 MMT.

Procuring at least 50% eligible renewable energy resources by 2030 (Section 454.52(a)(1)(B)). Both the SCE Preferred and Conforming Portfolios include expected levels of eligible renewable energy resources exceeding California's 50% RPS goal by 2030.

Enabling each electrical corporation to fulfill its obligation to serve its customers at just and reasonable rates and minimizing impacts on ratepayers' bills[70] **(Sections 454.52(a)(1)(C) and (D))**. As discussed previously, SCE believes the SCE Preferred Portfolio, including economy-wide measures, is the least-cost feasible path for meeting the state's ambitious 2030 GHG emissions goal. In order to evaluate the impacts of the portfolio on customers, it is important to estimate the effects not only on electricity bills and rates, but also on avoided household expenditures on fossil fuels.

The SCE Preferred Portfolio is part of an economy-wide strategy that includes electrifying high-GHG emitting end uses such as transportation and space and water heating while decarbonizing the electric sector to reliably meet customers' needs and California's GHG emissions goals while minimizing costs. Using the electric system to facilitate GHG reductions in other economic sectors will require investments in the electric sector, but the heavier utilization of the electric system will reduce customers' expenditures on fossil fuel-based resources.

SCE's rates and bills analysis shows that by 2030 the SCE Preferred Portfolio would result in upward pressure on rates, yielding an increase in the system average rate of 3.2 cents per kilowatt-hour ("kWh") (+19%) by 2030. Average residential customer bills will have less of a percentage increase, +9% or $10 per month, due to the increases in energy efficiency and BTM PV forecasted in the SCE Preferred Portfolio. These increases in average electrical bills are, however, offset by decreases in customer expenditures, primarily in gasoline. SCE's PATHWAYS modeling results show that by 2030, under SCE's Pathway, the average household will save $11 per month on gasoline given the higher levels of EV penetration in SCE's plan. The rate impacts of the SCE Preferred Portfolio and SCE Conforming Portfolio are further addressed in Sections III.B.2 and III.C.2.

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[70] Rate and bill impacts are reported in 2016 real dollars.

Ensuring system and local reliability (Section 454.52(a)(1)(E)). In developing the SCE Pathway System Plan, SCE enforced the 15% planning reserve margin as a constraint in the capacity expansion modeling. SCE also completed production cost simulation modeling and transmission impact analysis on the SCE Pathway System Plan to validate the operational feasibility and performance of the CAISO system-wide portfolio, evaluate its impact on SCE's transmission planning area, and identify resource additions in areas that minimize the need for new transmission and integration costs. SCE did not identify any system or local reliability concerns.

As addressed in Sections I.C.3, I.C.4, IV.A.2, and IV.C, there are certain issues not considered in IRP modeling (e.g., unplanned natural gas plant retirements and natural gas system constraints) that might cause system and/or local reliability concerns. SCE recommends that the CAISO study these issues in the 2019-2020 TPP, and that the Commission further consider these issues in the next IRP. The Commission should also adopt a reliability threshold mechanism to facilitate procurement and deployment of flexible energy storage resources to address any reliability issues that may arise in the interim.

Strengthening the diversity, sustainability, and resilience of the bulk transmission and distribution systems, and local communities (Section 454.52(a)(1)(F)). The SCE Conforming Portfolio is consistent with the Commission's Reference System Plan. Both the SCE Preferred and Conforming Portfolios have also been cost optimized and do not result in any transmission system reliability challenges. The SCE Preferred Portfolio includes significant additions of energy storage that will improve the sustainability and resilience of the transmission and distribution systems. Moreover, the SCE Preferred and Conforming Portfolios will strengthen local communities by reducing GHG emissions and air pollutants, especially the SCE Preferred Portfolio which is based on increased transportation electrification that will further reduce GHG emissions and air pollutants.

Enhancing distribution systems and demand-side energy management (Section 454.52(a)(1)(G)). The SCE Conforming Portfolio aligns with the Commission's Reference

System Plan. The SCE Preferred Portfolio includes substantial growth in transportation and building electrification, which increases demand-side management opportunities via load shifting and demand response.

Minimizing localized air pollutants and other GHG emissions with early priority on disadvantaged communities (Section 454.52(a)(1)(H)). The SCE Conforming Portfolio is consistent with the Commission's Reference System Plan, and GHG emissions and air pollutants attributable to SCE's bundled demand are expected to decline under the SCE Conforming Portfolio as discussed in Section III.C.1. As addressed in Section III.B.1, the SCE Preferred Portfolio is expected to reduce GHG emissions and air pollutants more significantly as a result of higher renewable resource additions and increased transportation and building electrification. SCE has also prioritized early actions in disadvantaged communities in both its procurement processes and its transportation electrification efforts as described in Section III.B.1.b.

Other statutory requirements. In Ordering Paragraph 10 of D.18-02-018, the Commission stated that in addition to including the statutory requirements Public Utilities Code Sections 454.51 and 454.52, LSEs' IRPs shall include other statutory requirements, including those associated with energy efficiency, demand response, the RPS, energy storage, and RA.

The SCE Preferred and Conforming Portfolios are consistent with current statutory requirements for each respective program. For energy efficiency, SCE included the Commission's required assumptions for the SCE Conforming Portfolio and reflected SB 350 goals by incorporating the CEC's 2017 IEPR-estimated SB 350 energy efficiency impact (or the CEC's 2017 IEPR "High_Plus_AAEE" scenario forecast) in the SCE Preferred Portfolio. With respect to the RPS, both the SCE Preferred and Conforming Portfolio include eligible renewable energy resources in excess of the state's 50% by 2030 RPS goal as noted above. For energy storage, SCE included existing energy storage mandates in its baseline resources for the SCE Preferred and Conforming Portfolios.

System RA for each LSE is required to meet its expected peak load need plus a planning reserve margin of 15%. The 2018 RA rulemaking will study and adopt RA requirements for

jurisdictional LSEs for the 2019 operating/compliance year. Local RA requirements are determined by the CAISO on an annual basis and are a consideration in the local area and for transmission constraints that restrict resources outside the local area from fully serving load in a local area. As with local RA, flex RA requirements are established by the CAISO based upon studies of the net load[71] served and the ramps that are created by the net load. The flex RA need is also determined in the year prior to the compliance/operating year and is only done for a single year forward. At this time, the RA requirements for system, local, and flexibility are not known for the entire long-term planning horizon assessed in the IRP.

In its SCE Pathway System Plan development, SCE considered the system peak load need plus a planning reserve margin of 15%, in order to ensure sufficient capacity in the system for the full planning horizon for all LSEs to meet their system RA requirements.

B. SCE Preferred Portfolio

SCE submits the SCE Preferred Portfolio, which is consistent with SCE's bundled load share of a 28 MMT 2030 GHG emissions planning target for the electric sector, as preferred for planning purposes in this IRP. The Commission's Reference System Plan (with a 42 MMT target) is an incomplete solution for achieving California's 2030 GHG emissions goal. SCE has concluded that a higher level of decarbonization in the electric sector, and more electrification of other sectors, is needed to facilitate a cost-effective and feasible path for reaching the state's 2030 emissions target.

To meet California's 2030 GHG emissions goal, CARB's 2017 Scoping Plan established a range of 30-53 MMT of 2030 emissions from the electric sector, and contributions from the

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[71] Net load in this context is viewed as the gross load less intermittent renewable resources (i.e., solar and wind). Since these resources can tend to produce output during a given period of the day and then cease or decrease output thereafter, the amount of gross load that must be served by other resources can dramatically increase causing a large ramp for those resources to meet.

cap-and-trade program in the range of 34 to 79 MMT.[72] The Commission's 42 MMT electric

sector GHG emissions planning target is near the center of CARB's target range. The 42 MMT

target assumes significant emissions reductions will be realized from the cap-and-trade program

without considering what measures will achieve such GHG abatement or how these measures

will affect the electric sector's emissions. In particular, the Reference System Plan reflects no

building electrification and only 3.3 million light-duty EVs by 2030.

SCE's GHG scenario analysis identified the Pathway, a combination of GHG abatement

measures that constitute the most feasible and economical approach to reaching the state's 2030

GHG emissions target. SCE's analysis determined that significant transportation electrification

(7 million EVs) and electrification of space and water heating end uses in buildings (nearly one-

third), along with cleaner electricity (80% carbon-free), are cost-effective GHG abatement

measures and key components of any feasible and cost-effective path for California to reduce

economy-wide GHG emissions 40% below 1990 levels by 2030. This is further supported in the

CEC Energy Research and Development Division's recently published *Deep Decarbonization in*

a High Renewables Future report, which determined that 6 million ZEVs, a 50% market share of

electric space and water heat pump sales, and 74% carbon-free electricity in 2030 are important

parts of a plausible, lower-cost, lower-risk High Electrification Scenario for achieving the state's

2030 and 2050 climate goals.[73]

Based on SCE's GHG scenario analysis and the resulting Pathway, the SCE Preferred

Portfolio is based on a 28 MMT electric sector GHG emissions planning target, and the load

effects of the electrification discussed above. The SCE Preferred Portfolio and the CAISO

system-wide SCE Pathway System Plan are preferred by SCE because they represent what

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[72] *See* CARB, *California's 2017 Climate Change Scoping Plan*, November 2017, at 31, available at:
https://www.arb.ca.gov/cc/scopingplan/scoping_plan_2017.pdf.

[73] *See* CEC Energy Research and Development Division, *Deep Decarbonization in a High Renewables Future*, June 2018, at 2-4, 18, available at:
https://efiling.energy.ca.gov/GetDocument.aspx?tn=223785.

resources are likely needed to meet California's 2030 GHG emissions goal at the lowest reasonable cost.[74]

2030 is just over 11 years away. LSEs, and in particular the IOUs, require regulatory approval for GHG reduction measures beyond current policies to allow the electric sector to pursue deeper decarbonization and serve as an enabler of GHG reductions across other sectors of the economy. To achieve this degree of decarbonization in the electric sector, long-term investments to develop new renewable resources and energy storage (approximately 16 GW of renewables and nearly 10 GW of energy storage by 2030 in the SCE Pathway System Plan) are needed. These resources, and any required transmission, may take several years to develop. Accordingly, the IRP process must support a highly decarbonized electric sector with high electrification to encourage LSEs to make the long-term investments and potentially guide the re-investment of cap-and-trade program funds to pursue further decarbonization of the electric sector.

1. **SCE Preferred Portfolio – GHG Emissions and Local Air Pollutant Minimization**

The SCE Preferred Portfolio significantly reduces both GHG emissions and air pollutants attributable to SCE's bundled load as it increases reliance on zero-carbon resources to 74% by 2030. It also includes considerably more transportation and building electrification than the Commission's Reference System Plan, facilitating GHG emissions and air pollutant reductions in other sectors. These emissions reductions will benefit SCE's service area, including disadvantaged communities ("DACs"), and the entire state. This section addresses how the SCE

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[74] SCE is ready to pursue its share of deeper electric sector decarbonization, but SCE cannot act alone. As discussed in Sections I.C.1 and IV.A.1, SCE's request to begin procurement of the resources in the SCE Preferred Portfolio is conditioned on: (1) adoption of a 2030 electric sector GHG emissions planning target of 28-30 MMT and higher electrification assumptions consistent with SCE's Pathway for all LSEs filing IRPs; and (2) adoption of the IOUs' GAM/PMM proposal or a similar equitable departing load cost allocation mechanism to replace the PCIA methodology.

Preferred Portfolio will reduce GHG emissions and air pollutants, including prioritizing early emissions reductions in DACs; outlines the SCE service area's DAC demographic profiles and the GHG-emitting resources that are in and near those communities; and discusses SCE's existing and planned programs affecting DACs.

a)   SCE Preferred Portfolio Emissions Results

As previously discussed, the Pathway's electric sector GHG emissions in 2030 are 28 MMT, and this value defined the electric sector GHG emissions planning target in the Pathway scenario. The SCE Preferred Portfolio was designed to meet its pro rata share of this lower target, which equates to 5.1 MMT. Because SCE modeled its portfolio using a mass-based GHG constraint, it set targets for each intervening year between 2018 and 2030 via straight-line reduction.

After completing portfolio modeling, SCE used the Commission's CNS methodology[75] and CNS Calculator to measure expected emissions attributable to the SCE Preferred Portfolio with three major modifications.[76] First, in addition to accounting for GHG emissions, SCE modified the CNS Calculator tool to include NOx and fine particulate matter ("PM2.5") emissions, accounting for both steady state operations and starts and stops. As described in Appendix F, SCE performed post-processing calculations, using both its SCE Pathway System Plan production cost simulation outputs[77] and the estimated emissions per start from similar sources to those used in the Commission's Reference System Plan analysis.

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[75] *See Administrative Law Judge's Ruling Finalizing Greenhouse Gas Emissions Accounting Methods, Load Forecasts, and Greenhouse Gas Benchmarks for Individual Integrated Resource Plan Filings*, R.16-02-007, May 25, 2018, at Attachment A.

[76] A more detailed description of SCE's CNS calculation methodology is included in Appendix F, SCE's CNS Calculation Methodology.

[77] Production cost simulation optimizes dispatch of all resources to meet system needs. While the model results provide valuable information on the system performance given a portfolio of resources, it is not a substitute for observed CAISO resource dispatch. Therefore, the emission results should be considered modeled proxies for emissions that could be produced in the future.

Second, SCE analyzed emissions from plants running at minimum load to support system reliability ("Pmin") from its SCE Pathway System Plan production cost simulations, and included its bundled service customers' pro rata shares of such emissions in the analysis. The CNS Calculator does not account for Pmin, which systematically undercounts emissions attributable to LSEs' portfolios. In real market operations, these plants remain online mid-day to be prepared to serve the evening ramp when demand increases around the same time solar production declines.

Third, SCE did not include any credits for over-generation in calculating the GHG emissions for the SCE Preferred Portfolio.

The SCE Preferred Portfolio's GHG, NOx, and PM2.5 emissions are all significantly lower than present levels by 2030, as shown in Table III-7.[78]

Table III-7
SCE Preferred Portfolio CNS Calculator Emissions Results

Emissions type (units)	2018	2022	2026	2030
GHG (MMT)	14.3	7.8	6.6	4.8
PM2.5 (MT)	743	382	318	223
NOx (MT)	1391	834	798	572
% change from 2018				
GHG		-45%	-54%	-66%
PM2.5		-49%	-57%	-70%
NOx		-40%	-43%	-59%

b) **SCE Preferred Portfolio Procurement Processes and Early Priority for DACs**

Although neither the Commission's CNS methodology nor SCE's modified CNS calculation methodology including NOx and PM2.5 emissions provide sufficient granularity to

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[78] SCE's CNS Calculators for the SCE Preferred Portfolio are included as Appendix G.1, CNS Calculator (GHG) – SCE Preferred Portfolio; Appendix G.2, CNS Calculator (NOx) – SCE Preferred Portfolio; and Appendix G.3, CNS Calculator (PM2.5) – SCE Preferred Portfolio.

specifically assess the amount of emissions reductions in DACs, the SCE Preferred Portfolio substantially reduces emissions. This will benefit both DACs and other communities throughout California. SCE also addresses its early prioritization of DACs in three ways: first, to examine the locations of proposed new resources and anticipated procurement practices; second, to discuss how it may address emissions from currently contracted or owned natural gas plants; and third, to highlight how SCE's planned transportation electrification efforts will help to alleviate GHG emissions and air pollution in DACs.

(1)   SCE Preferred Portfolio Locational Information

The following map provides a perspective on the quantity and location of the additional renewable resources needed to support the SCE Preferred Portfolio. SCE proposes no new natural gas plants as part of the SCE Preferred Portfolio. All incremental resources are renewables and energy storage. Given SCE's service area contains over 1,100 census tracts designated as DACs,[79] spread across various counties, many of the new resources identified in the SCE Preferred Portfolio could be located in proximity to DACs.

SCE does not define specific locations for resources in its IRP, as project siting is managed by developers and it would not be prudent for SCE to define specific locations for projects based on system-wide or bundled portfolio modeling. As further discussed below, SCE currently gathers locational information and information regarding proximity to DACs for specific projects through the procurement process, and evaluates these factors as part of the evaluation and selection process.

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[79]   In the 2010 census, there were 8,057 census tracts in California. 2,007 of those census tracts are DACs.

Figure III-10
SCE Preferred Portfolio Modeled Renewable Capacity Expansion by Region and Type

(2)   Consideration of DACs in the Procurement Process

In addition to Public Utilities Code Section 454.52(a)(1)(H)'s direction that LSEs' IRPs "[m]inimize localized air pollutants and other greenhouse gas emissions, with early priority on disadvantaged communities," there are statutory provisions regarding consideration of DACs and environmental justice issues in the procurement process. Public Utilities Code Section 399.13(a)(7)(A) provides that, in soliciting and procuring eligible renewable energy resources for California-based projects, electrical corporations "shall give preference to renewable energy projects that provide environmental and economic benefits to communities afflicted with poverty

or high unemployment, or that suffer from high emission levels of toxic air contaminants, criteria air pollutants, and greenhouse gases."[80] Public Utilities Code Sections 454.5(b)(9)(D)(i) states that, in soliciting bids for new gas-fired generating units, electrical corporations "shall actively seek bids for resources that are not gas-fired generating units located in communities that suffer from cumulative pollution burdens, including, but not limited to, high emission levels of toxic air contaminants, criteria air pollutants, and greenhouse gases." Electrical corporations shall also provide greater preference to resources that are not gas-fired generating units located in such communities when considering bids for, or negotiating contracts for, new gas-fired generating units.[81] SCE implements these requirements through its procurement evaluation criteria.

SCE typically uses a least-cost, best-fit methodology to evaluate and select resources to meet a specified need through competitive solicitations. The least-cost aspect of the methodology ensures that quantifiable attributes are considered and used to develop an NPV assessment of the proposed offer by subtracting the present value of costs from the present value of realizable benefits. These cost and benefit components include items such as fixed and variable contract payments, transmission and distribution upgrade costs, energy value, and RA value. The best-fit aspect of the methodology allows SCE to consider non-quantifiable attributes of the offer such as viability, location, counterparty concentration, technology preferences, and loading order.

SCE would assess the impact to a DAC from selecting a particular offer in a portfolio as part of the best-fit analysis (along with other factors), and explain this impact as part of its request for Commission approval of the procurement. It is difficult to know the impact of a portfolio selection on a DAC; however, having upfront flexibility in the procurement process allows SCE to consider DACs in the context of the full selection portfolio. This flexibility is consistent with Public Utilities Code Section 454.52(a)(2)(B), which allows the Commission to

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[80] This section applies regardless of the procurement mechanism. *See* Cal. Pub. Util. Code § 399.13(a)(7)(B).

[81] *See* Cal. Pub. Util. Code § 454.5(b)(9)(D)(ii).

approve procurement that will reduce overall GHG emissions from the electric sector and meet other IRP goals, such as early prioritization of DACs, even if the resource does not compete favorably in terms of price with other resources over the time period of the IRP.

As previously discussed, the SCE Preferred Portfolio does not include any new natural gas plants and SCE is not proposing to develop any new natural gas plants or re-contract with existing natural gas plants for a period of five years or more through this IRP. SCE does, and will continue to, ascribe a qualitative benefit to preferred resources and energy storage resources located in DACs during SCE's procurement valuation and selection. To the extent SCE conducts procurement for renewable resources, SCE will provide qualitative preferences to projects that provide benefits to DACs or other communities meeting the criteria in Public Utilities Code Section 399.13(a)(7)(A).

These qualitative preferences could result in promoting a lower-NPV project onto the shortlist, eliminating a higher-NPV project not located in a DAC from shortlist consideration, or determining a tiebreaker between two projects with equivalent or near-equivalent NPVs, where one is located in a DAC. As such, SCE has selected and will likely continue to select projects for its shortlist that do not have the highest NPVs, accounting for qualitative considerations such as DAC location.

For example, consider a set of four portfolios that each meet the needs of the specified procurement with Portfolios 1 through 3 having the same net cost or NPV, and Portfolio 4 being $100,000 (less than 5%) extra in net cost. Portfolio 1 meets all of the needs with no preferred resources located in a DAC; Portfolio 2 meets all of the needs with two small storage resources located in a DAC, both based on a new technology; Portfolio 3 meets all of the needs with one large storage resource located in a DAC using a proven technology; and Portfolio 4 meets all of the needs with a combination of resources located in a DAC, including energy efficiency, storage, and demand response, all using proven technologies and measures. Portfolios 2 and 3 would be considered superior to Portfolio 1 from a DAC perspective. However, both portfolios present some challenges. Portfolio 2 is relying on new technologies that have a higher risk and

may not deliver or meet the specified need, while Portfolio 3 has concentration risk by relying on one resource and technology type. Given the relatively modest net cost difference for Portfolio 4, which has DAC resources, project diversity, technology diversity, and proven technologies and measures, it would be reasonable to move forward with Portfolio 4 as the recommended portfolio to meet the specified need. This would only be possible if there was flexibility in the valuation and selection process with the appropriate use of the least-cost, best-fit methodology.

SCE plans to conduct outreach and seek input from DACs that could be impacted by its procurement activities. SCE's specific outreach plans will depend on the location and other details of each solicitation. However, community outreach may include utilizing existing SCE's Clean Energy Access Working Group and other existing advisory panels as described below, as well as outreach to government officials and community stakeholders in the DACs affected by the procurement.

(3)   Existing Contracted and Owned Natural Gas Plants

The CAISO system currently relies on natural gas plants to provide reliability and renewable integration services. With California moving towards a decarbonized future and the system adding large amounts of carbon-free generation, however, it is likely that more natural gas plants will retire based on economics. In D.18-02-018, the Commission acknowledged the need for further work regarding the impacts on the natural gas fleet in California, and noted that parties had raised the need for: better location-specific understanding of the value of natural gas resources on the system; identification of operational challenges that will emerge or be exacerbated as the amount of renewable generation grows; whether services currently provided by natural gas resources can be economically replaced by other resources; and how to ensure least-cost reliability through CAISO market mechanisms and capacity development in the RA or IRP processes.[82]

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[82]   *See* D.18-02-018 at 143-146.

As explained in Sections I.C.3 and IV.A.2, SCE recommends that the Commission ask the CAISO to analyze the system and local reliability impacts of reductions in revenue for natural gas plants and the potential economic retirements of such plants in the CAISO's 2019-2020 TPP. This study would provide the Commission valuable information for its consideration of natural gas fleet issues in the next IRP cycle.

SCE is also evaluating its owned natural gas peaker plants for potential emissions reduction opportunities. Specifically, SCE is evaluating the potential to implement Enhanced Gas Turbine ("EGT") retrofits on its three remaining un-retrofitted peaker plants, which are all located in DACs. SCE already has experience with EGTs integrating energy storage at two of its peaker plants, as described below. SCE is assessing this technology for emissions reduction effectiveness, economic viability, and potential application to its three remaining peaker plants.

Beginning in 2006, pursuant to Commission direction, SCE developed five gas turbine peaker power plants in response to unprecedented heat waves and low system capacity. Each peaker plant uses a state-of-the-art, simple-cycle combustion turbine generator set, operated with selective catalytic reduction for NOx air pollution reduction and an oxidation catalyst for carbon monoxide and volatile organic compound air pollution reduction. Each peaker plant includes one General Electric LM6000 SPRINT™ (SPRay INTercooling) natural gas turbine generator set and associated auxiliary equipment. The peaker plants are Grapeland (in Rancho Cucamonga), Mira Loma (in Ontario), Barre (in Stanton), McGrath (in Oxnard), and Center (in Norwalk). All five peaker plants are in DACs.

In 2017, in response to Commission direction regarding the need for energy storage resources to address reliability issues caused by limited operations of the Aliso Canyon natural gas storage facility,[83] SCE contracted to develop the world's first hybrid EGT power plants, which included the addition of battery energy storage systems to the peaker plants at Rancho

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[83] *See* Resolution E-4791.

Cucamonga and Norwalk. The Commission recently approved cost recovery for these EGTs in D.18-06-009.

The hybrid EGT units at Rancho Cucamonga and Norwalk are now operating, and preliminary results indicate that GHG emissions and criteria pollutants are being reduced over the prior year, while the EGTs increase support to the electric grid and renewables integration. The remaining peaker plants at Ontario, Stanton, and Oxnard, which are all in DACs and are not EGTs, present possible opportunities to support reducing localized air pollutants and GHG emissions, with early priority on DACs in accordance with Public Utilities Code Section 454.52(a)(1)(H).

Preliminary work is underway, and assuming the analysis provides support for additional EGT conversions, SCE will propose conversion of one or more units to the Commission for approval and cost recovery.

(4)   Transportation Electrification

The SCE Preferred Portfolio also recognizes the emissions reduction potential of electrifying transportation. The Commission's Reference System Plan analysis demonstrated that most air pollutant emissions are attributable to motor vehicles (especially for NOx emissions) and other mobile sources. Commission staff concluded that motor vehicles and other mobile sources create between 60-75% of 2030 NOx emissions, depending on location, compared to 2-4% from electric utilities.[84] Similarly, motor vehicles and other mobile sources create between 12-22% of 2030 PM2.5 emissions, depending on location, compared to 1-2% from electric utilities.[85] As such, it is important to consider how the electric sector can facilitate reducing these harmful air pollutants in DACs, and statewide, by enabling clean electrified transport and helping drivers move away from tailpipe-emitting internal-combustion engine vehicles.

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[84]   *See Proposed Reference System Plan*, September 18, 2017, at 92.
[85]   *See id.* at 93.

The SCE Preferred Portfolio assumes the deployment of approximately 7 million EVs statewide by 2030, including light-, medium-, and heavy-duty EVs. This, in addition to deep electric sector decarbonization, will play a significant role in emissions reductions in DACs. As described in SCE's Pathway white paper,[86] transportation electrification can result in 58 MMT of GHG emissions reduction by 2030, which represents approximately one-third of the total GHG emissions reductions required (from 2015 levels) to achieve California's 2030 goal. Electrification of the transportation sector will also greatly improve local air quality – an urgent community need across California and particularly in Southern California. Many communities, particularly DACs, are situated near heavily traveled freight corridors, where the concentration of air pollutants often exceeds health-based standards.[87]

In order to support approximately 7 million EVs by 2030, California will need to support significant away-from-home charging infrastructure and charging infrastructure at multi-unit dwellings. In SCE's service area specifically, the SCE Preferred Portfolio assumes approximately 2.59 million light-duty EVs, as well as additional medium- and heavy-duty EVs. This will require commensurate increases in charging infrastructure, including in DACs. SCE is already working toward enabling this level of adoption within its service area. More information regarding SCE's transportation electrification-related programs benefitting DACs is included in Section III.B.1.d.1 below.

c)   **DACs in SCE's Service Area**

The Commission has rightly recognized that in order to put an early priority on emissions reductions in DACs, LSEs must identify the DACs they serve and evaluate the current and planned programs that work to support clean energy access and equity in these communities.

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[86]   *See* Appendix A at 6-8.

[87]   Electrification in areas such as the I-710 corridor between Long Beach and Los Angeles promotes environmental justice by ensuring that climate investments provide near-term air quality benefits to a broad set of communities.

SCE has identified the DACs in its service area based on the criteria established by the Commission.[88] The following provides a general description of the DACs served by SCE, and SCE customers served in DACs.[89] More detailed information, including the natural gas plants in these communities and information on community engagement, is included in Appendix H.[90]

Of the state population living in DACs, 47% reside in SCE's service area. In SCE's service area, approximately 40% of SCE's residential households are in DACs and/or have subsidized rates. The majority of the DACs in SCE's service area are clustered along major transportation routes, where the emissions from internal-combustion engines significantly affect the areas. This includes communities such as South Los Angeles, San Bernardino, and San Joaquin Valley.

There are 1,107 census tracts in SCE's service area that are designated as DACs. The key demographics for each census tract are available, but due to the dense urban nature of many of them, aggregating to the county subdivision makes sense for the majority of them. Where the DAC-designated census tracts are a significant minority of the census tracts in the subdivision, SCE recommends a more granular approach. To arrive at the number of DACs and county subdivisions used for the DAC demographic descriptions, SCE used ArcGIS to evaluate layered data from the CalEnviroScreen 3.0, SCE's system geolocation data, and the ArcGIS layer for county subdivision boundaries. The use of these data layers in ArcGIS resulted in identifying 69 county subdivisions with designated DACs in SCE's service area. Some of the in-area designations come from closely shared borders with other LSEs, even if the geographic region at these over-laid geographic regions may not actually include customers or facilities.

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[88] The Commission defined a DAC as any census tract scoring in the top 25% of impacted census tracts on a statewide basis or within the top 5% of census tracts without an overall score but with the highest pollution burden, using the CalEnviroScreen tool. *See* D.18-02-018 at OP 6.

[89] Data provided within this section is from CalEnviroScreen 3.0. The data may be accessed at: https://oehha.ca.gov/media/downloads/calenviroscreen/document/ces3results.xlsx.

[90] *See* Appendix H, Demographics of DAC-Designated Census Tracts, Aggregated to County Subdivision, in SCE's Service Area.

However, SCE chose to include these DACs and county subdivisions in its description of the demographics of the county subdivisions in Appendix H.

d) Current and Planned Programs and Activities Impacting DACs

The following information provides a summary of current and planned SCE programs and activities that impact DACs or contribute to economic development within DACs.

(1) Customer Programs

SCE implements and manages a diverse portfolio of energy products, programs and services for its customers to help in energy efficiency, EV, and renewable energy adoption. While these programs are offered to customers throughout SCE's service area, there may be some programs in which greater marketing and outreach to DACs may occur.

These programs include the following residential tariffs.

Tariff Type	Tariff Offering
Standard	• Tiered • Time-of-Use • Green
Discounted (based on income qualifications or participation in select public assistance programs)	• California Alternate Rates for Energy ("CARE") • Family Electric Rate Assistance
Baseline Allowance	• Medical Baseline • All-Electric Baseline

SCE also offers the following energy management programs.

Program	Details
Energy Savings Assistance Program	• No cost energy-efficient appliance replacement for eligible customers, based on income qualifications or participation in select public assistance programs
Comprehensive Manufactured Home Program	• No cost energy upgrades for qualifying mobile homes and mobile-home communities

Home Energy Efficiency Rebates	• Rebates to offset purchase of energy-efficient products such as: variable speed pool pump, evaporative cooler/window evaporative cooler, hybrid electric heat pump water heater, whole house fan, home area network, and smart thermostat
Energy Upgrade California Home Upgrade	• Financial incentives for installing approved whole-house energy upgrades in homes
Summer Discount Plan	• Bill credits for allowing SCE to temporarily cycle central A/C during energy events
Home Energy Advisor	• Free online survey, providing customized tips for reducing energy usage

SCE offers the following programs facilitating transportation electrification.

Program	Details
Clean Fuel Rewards Program	• Rebate for the purchase or lease of a new or used EV
Charge Ready Home Installation Rebate	• One-year pilot, providing a rebate to offset cost of permit and electrician fees when installing a home charging station. • For first six months of pilot, 50% of rebate funds are reserved for DACs

In addition to rebates for residential customers driving EVs, SCE is engaged in a number of transportation electrification infrastructure projects. This is of particular importance to DACs that fall along the goods movement corridors at the sea ports, the I-710, and Inland Empire goods movement and storage areas. These projects include:

- **Charge Ready Light-Duty:** As of June 4, 2018, SCE has installed 1,003 charge ports (at 65 sites) out of a total of expected 1,250 charge ports. Of the 1,145 charge ports committed with reserved funding, 553 are in DACs (48% of projects), exceeding the pilot's goal to deploy 10% of charge ports in DACs.

  o SCE recently filed an application requesting approval of Charge Ready 2, which would support an additional 48,000 charge ports, of which at least 30% will be

installed within DACs.[91] In the interim, SCE has requested that the Commission authorize bridge funding to extend the Charge Ready Pilot until the Commission issues a decision on the Charge Ready 2 application.[92]

- **Charge Ready Transit Bus***:* In this pilot, SCE will work with government transit agencies to provide infrastructure to service 60 to 120 buses. The pilot will seek to maximize electric transit bus routes in DACs.

- **Port Electrification:** These projects are providing infrastructure to electrify yard tractors and rubber tire gantry cranes to reduce emissions in heavily impacted DAC areas near the Port of Long Beach.

- **DC Fast Charge ("DCFC") Pilot:** SCE will deploy the electric infrastructure to support five DCFC sites accessible to all drivers. The sites will be located within or adjacent to DACs.

- **Charge Ready Transport:** SCE will install infrastructure for at least 870 customer sites by 2024 to support a minimum of 8,490 medium- and heavy-duty EVs.
  - At least 25% of the program's infrastructure budget will be dedicated to vehicles operating at sea ports and warehouses in SCE's service area, which are in heavily impacted DAC areas.
  - In addition to the infrastructure, eligible participants in DACs will receive a rebate for as much as half of the cost of the EV charging stations.

In addition, SCE offers the following renewable energy programs.

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[91] *See Application of Southern California Edison Company (U 338-E) for Approval of its Charge Ready 2 Infrastructure And Market Education Programs*, A.18-06-015, June 26, 2018.

[92] *See Southern California Edison Company's (U- 338-E) Petition for Modification of Decision 16-01-023 Regarding Southern California Edison Company's Application for Charge Ready and Market Education Programs*, A.14-10-014, March 5, 2018.

Program	Details
Multi-family Affordable Solar Homes	• For multifamily building owners to offset the cost of installing a new solar energy system for common areas and/or to reduce energy costs for low-income tenants
Solar for Affordable Housing ("SASH")	• Administered by Grid Alternatives for the Commission, provides incentives to qualified low-income homeowners to help offset the costs of a solar electric system • Solar + Storage Pilot for Low-Income Housing and Subsidized Green Rate for CARE customers • Provides a flexible, transparent structure that supports the proliferation of solar in DACs

Pursuant to D.18-06-027, SCE will soon offer the following three new programs to facilitate installation of renewable generation among residential customers in DACs.

Program	Details
DAC-SASH[93]	• Modeled after existing SASH program • Available to low-income customers who are resident-owners of single-family homes in DACs • Provides up-front financial incentives towards the installation of solar generating systems on homes of low-income customers
DAC-Green Tariff[94]	• Modeled after the Green Tariff portion of the Green Tariff Shared Renewables program • Available to customers who live in a DAC and meet the income eligibility requirements for CARE or Family Electric Rate Assistance Program • Provides a 20% rate discount compared to the customer's otherwise applicable tariff

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[93] *See* D.18-06-027 at 2-3.
[94] *See id.* at 3.

Program	Details
Community Solar Green Tariff[95]	• Another variation on the Green Tariff Shared Renewables program, structured similarly to the DAC-Green Tariff • Allows primarily low-income customers in DACs to benefit from the development of solar generation projects located in their own or nearby DACs

(2) Economic Development

SCE has long been committed to developing and maintaining working partnerships with diverse suppliers (Women, Minority, and Service Disabled Veteran) and LGBT (Lesbian, Gay, Bisexual and Transgender) business enterprises. In 2018, SCE is providing direct and in-kind support of over $1.1 million to 58 diverse organizations for membership and sponsorship. This funding includes organization memberships, conferences, custom programs, and workshops. The organizations represent a broad spectrum of community interests, and serve DACs throughout SCE's service area.

(3) Ongoing Community Outreach

SCE works closely with community-based organizations, as well as leaders from key customer segments, to increase awareness about safety, promote programs and services, hear feedback, and align on common goals.

(a) Clean Energy Access Working Group

SCE has partnered with The Greenlining Institute to form the Clean Energy Access Working Group. The joint aim is to develop community-centric solutions for air quality and climate change issues. This partnership is a major step toward direct engagement on clean energy access, air quality, and climate change issues in Southern California.

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[95] *See id.* at 3-4.

Greenlining facilitates a collaborative conversation between SCE and 53 members from 37 organizations representing environmental advocacy organizations, community-based organizations, clean tech companies, solar developers, EV advocates, environmental justice organizations, faith based organizations, and academia. Working together, the parties can craft and support state and local policies and programs to improve air quality for environmentally impacted communities and bring clean energy technology investment, clean energy jobs, and job training to communities.

(b)   Valley Clean Air Now

SCE has partnered with Valley Clean Air Now ("Valley CAN"), administrator of a scrap-and-trade program in the San Joaquin Valley, where several DACs are located. Valley CAN is a nonprofit organization committed to improving air quality in the San Joaquin Valley, home of many high-polluting, older, and unregistered cars that do not meet state emissions standards. SCE supports Tune In & Tune Up, Valley CAN's smog repair program. Tune In & Tune Up events are held throughout the year to give residents a free emissions test to determine whether their vehicle qualify for free repairs at a local STAR-certified smog shop.

(c)   Advisory Panels

SCE has also convened several advisory panels as part of an ongoing effort to facilitate dialogue and build relationships in order to understand key issues important to stakeholders. The forums provide a sounding board for prospective company initiatives and policies and bring greater awareness of SCE's positions on current issues. SCE works to ensure DAC interests are represented on advisory panels. For example, the Consumer Advisory Panel has board members representing all regions of SCE's service area, including those with a special interest in low-income and minority communities, rural communities, Native American communities, and faith-based organizations. SCE's advisory panels include:

- Consumer Advisory Panel
- Government Advisory Panel

- Business Advisory Panel

- Small Business Advisory Panel

- California Large Energy Consumer Association Advisory Panel

- California Manufacturers & Technology Association Advisory Panel

(4) Planned and Completed Outreach Activities Related to DACs Specific to this IRP

Prior to the filing this IRP, SCE engaged with stakeholders that represent DAC interests. These activities included calls with representatives from environmental justice organizations in May 2018 to share details on SCE's approach to the IRP, and how the organizations could work collaboratively on shared DAC issues. In late July 2018, a workshop including discussion of the IRP and its potential impact on DACs was provided to SCE's partners from the Clean Energy Access Working Group, the Consumer Advisory Panel, and environmental justice organizations at SCE's Big Creek facility.

After August 1, 2018, SCE will continue outreach and engagement activities with DAC stakeholders, through arranged events and individual outreach. SCE will continue to engage with the Clean Energy Access Working Group, the Consumer Advisory Panel, environmental justice organizations, and local government officials in DACs, through regular email and/or webinar updates. Ongoing engagement will continue with stakeholders to ensure alignment and support as needed.

2. SCE Preferred Portfolio – Cost, Rate, and Customer Bill Analysis

The most effective and economic reduction of GHG emissions throughout California will depend upon a coordinated approach across multiple sectors of the state's economy. The SCE Preferred Portfolio, with its more aggressive GHG emissions target, is derived from a multi-sector decarbonization analysis and accounts for load increases due to electrification efforts and load decreases from increased penetration of energy efficiency and BTM PV. There are significant differences in GHG emissions reduction targets, forecast load and associated load

shapes, and assumptions around the cost and energy production of existing RPS contracts between the Commission's default scenario, the Commission's Reference System Plan, the SCE Conforming Portfolio, and the SCE Preferred Portfolio. These differences make a comparison of forecast cost and rate profiles of these various portfolios unhelpful. The Commission's default scenario and the Commission's Reference System Plan and the resulting SCE Conforming Portfolio would need to start from an economy-wide decarbonization approach before a comparison with the SCE Preferred Portfolio would yield relevant insights.

Given this structural limitation, it is necessary to view the SCE Preferred Portfolio from the perspective of how the electric sector must transform from its current trajectory and expand its role to enable the California economy to meet the state's 2030 GHG emissions goal. While SCE's plan to leverage the electric sector as a key tool in meeting the state's climate goals represents a least-cost path relative to other alternatives, further decarbonizing the electric grid and enabling the shift away from more GHG-emitting fuels will require economy-wide investments in renewables, customer-side GHG-free resources, integration and enabling technologies, and electrification measures. These investments will facilitate reductions in the expenditures and the negative environmental impacts that accompany fossil fuel use.

SCE forecasts that enabling this transition will result in moderate upward pressure on average rates (but less upward pressure on average bills) for customers through 2030. These rate impacts are due in part to the procurement of a diverse portfolio of renewables and energy storage resources that support renewable integration and other grid needs, reaching a nearly 80% carbon-free generation resource mix by 2030. Additionally, less energy consumption over the same time period due to greater deployment of BTM PV and energy efficiency further contribute to rate pressures. Conversely, by 2030, meeting SCE's proposed levels of transportation electrification and building electrification increases consumption of electricity and provides downward rate pressure by distributing the investment and procurement costs over more kWh sold. These impacts on electric utility customers will be further offset by reductions in customer

expenditures on gasoline, natural gas, and other fossil fuels and the accompanying societal benefits of reduced GHG and particulate emissions.

a) Baseline Revenue and System Average Rate Assumptions and Forecast

Pursuant to Commission guidance, SCE analyzed the impacts of the SCE Preferred Portfolio on bundled service customer rates relative to SCE's baseline revenue and rates forecast, which is based on data submitted in the 2017 IEPR (referred to as SCE's "Baseline" forecast). SCE's Baseline revenue and rate forecast model includes SCE's total revenue requirement by rate component. This revenue and rates forecast reflects existing policies (e.g., 50% RPS by 2030, IEPR mid-case AAEE, existing energy storage mandate, etc.) and a forecast of SCE energy contract expenditures. The model allocates total revenue to bundled service and departing load customers (including CCA and electric service provider ("ESP") customers) through 2030, consistent with current cost responsibility across customer classes.

Additional major assumptions of the Baseline revenue and rates forecast include: General Rate Case ("GRC") revenue consistent with SCE's 2018 GRC application levels, including long run increases averaging 3% and transmission revenue increases averaging 3% through 2030. The Baseline forecast also includes revenue for SCE's already-approved transportation electrification programs and pilots and forecasts of demand-side management programs, such as energy efficiency. The Department of Water Resources bond charge of almost $400 million ends in 2023. The Baseline forecasts assumes no change to the current PCIA methodology throughout the forecast period.

Financial assumptions used to create the Baseline revenue and rates forecast are consistent with the Commission's Reference System Plan and are carried through to develop the SCE Preferred Portfolio revenue and rates forecast. These assumptions include: asset lives of 65 years for distribution substation equipment, 33-59 years for distribution poles and lines, 20 years for meters, 40 years for transmission station equipment, 61-65 years for transmission lines and

towers, and 45 years for general building; capitalization of eligible operation and maintenance ("O&M") expenses at 45.50% for pension and benefits and 24.05% for administrative and general; cost escalation and inflation rates (2-3%); labor loaders of 46%; a weighted average cost of capital of 7.90%; federal income taxes at 35%;[96] state income taxes at 8.84%; and other tax related assumptions such as bonus depreciation and tax repair eligibility that were in place at the time of SCE's 2018 GRC application.

Baseline revenue modeling using these assumptions shows that system average rates are expected to increase by 7 cents per kWh from 2018 to 2030. This increase is made up of approximately 2 cents per kWh in real cost and approximately 5 cents per kWh from inflation.

Table III-8
Revenue Requirement Components - Baseline (2016$)[97]

Cost category (2016$)	2030
Distribution	5,641,715
Transmission	1,241,178
Generation	4,937,174
Demand-side Programs	375,009
Other	3,744
Baseline Revenue Requirement	12,198,820
System Average Rate (2016$ cents/kWh)	**17.2**

b) **SCE Preferred Portfolio Revenue and System Average Rate Assumptions and Forecast**

SCE's revenue and rates forecast of the SCE Preferred Portfolio generally reflects the annual modeled capacity additions summarized in Figure III-9 in the SCE Preferred Portfolio study results in Section III.A.1.b, and the load and system assumptions summarized in Table II-5, with the exception of new energy storage resources. SCE's revenue and rates forecast

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[96] Consistent with the Commission's RESOLVE model assumptions, made before federal tax rates were reduced in early 2018.

[97] Based on the revenue requirement components in the Proposed Reference System Plan. *See Proposed Reference System Plan*, September 18, 2017, at 46.

assumes that energy storage begins to come online in 2027 (instead of 2029 as shown in Figure III-9), and the full capacity to be added (1,586 MW by 2030) is evenly spread across the last four years of the forecast period. Early deployment of energy storage resources more closely aligns with SCE's action plan and goals around System-Optimized Storage Resources, as described in Section IV.A.1.c.4. This energy storage can address potential reliability concerns, improve grid efficiency, and meet impending renewable integration needs.

In developing the revenue and rates forecast of the SCE Preferred Portfolio, SCE also used several different input assumptions than those provided in the RESOLVE data set. These different assumptions were used to more accurately estimate the costs impacts of the SCE Preferred Portfolio on SCE's bundled service customers. One key difference is in the use of SCE's internal contract costs for its existing RPS contracts, rather than those found in RESOLVE. The costs for SCE's RPS contracts as compared with those found in RESOLVE are between 15% and 30% lower, and more accurately reflect the total costs of those contracts through 2030. The SCE Preferred Portfolio also assumes the IOUs' GAM/PMM proposal will be adopted to replace the current PCIA methodology, which would equitably allocate long-term contracted generation costs to departing load customers.

Another key input difference that SCE used in developing its SCE Preferred Portfolio cost and rates analyses is the assumed pricing of future renewable and energy storage resources. The prices for candidate renewable and energy storage resources provided in RESOLVE are in some cases significantly higher than SCE's experience with current pricing for similar resources. Therefore, while SCE used RESOLVE technology prices to model its capacity expansion portfolio, for cost, rate, and bill analysis, SCE chose to use its proprietary price forecasts, projected forward using RESOLVE technology curves, to more closely reflect current candidate resource prices.

Additionally, since individual generator dispatch data were not provided in the RESOLVE assumptions, SCE used simulated generator dispatch data and operations costs from the production cost simulation modeling of the SCE Pathway System Plan based on proprietary

natural gas and GHG price forecasts. These simulated dispatch schedules and operations costs were key inputs to the generation revenue requirements forecast, but diverge from the RESOLVE modeling assumptions and outputs.

c)   SCE Preferred Portfolio Revenue, System Average Rate, and Customer Bill Results

The SCE Preferred Portfolio exhibits overall declining bundled electricity consumption at an approximately 4.5% compounded annual growth rate ("CAGR") through the forecast period. There are several factors influencing this result: increased electricity consumption from transportation and building electrification is largely offset by higher levels of energy efficiency and customer solar adoption in the SCE Preferred Portfolio revenue and rates forecast than in SCE's Baseline revenue and rates forecast.[98] These factors combined lead to the SCE Preferred Portfolio having nearly 17 terawatt-hours[99] less bundled energy consumption relative to the Baseline revenue and rates forecast.

Like the Baseline revenue and rates forecast, the SCE Preferred Portfolio revenue and rates forecast includes revenue for SCE's approved transportation electrification programs, but also adds revenue for SCE's recently filed Charge Ready 2 application to help facilitate the adoption and optimal charging of EVs in SCE's service area.[100] Additionally, while there is additional procurement of renewable and energy storage resources in the SCE Preferred Portfolio, CCA departures reduce the total generation costs compared to the Baseline forecast. Finally, the SCE Preferred Portfolio revenue requirement increases are partially offset by

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[98]   Bundled energy sales in the Baseline revenue and rates forecast decline at an approximately 1.6% CAGR over the forecast period.

[99]   In 2030, the bundled energy forecast is 59,874 GWh in the Baseline forecast and 42,908 GWh in the SCE Preferred Portfolio forecast.

[100] *See Application of Southern California Edison Company (U 338-E) for Approval of its Charge Ready 2 Infrastructure And Market Education Programs*, A.18-06-015, June 26, 2018.

increased GHG allowance revenue, due to higher forecasted GHG allowance auction prices relative to the Baseline.

The combined effects of declining bundled energy consumption, increases in renewable procurement and electrification program expenditures, and decreases in generation expenses due to CCA departure result in an estimated 2030 system average rate increase of approximately 19% or 4.3 cents per kWh on a nominal basis and 3.2 cents per kWh on a real basis. By 2030, average residential customer bills, however, increase 9% or approximately $13 per month on a nominal basis and $10 per month on a real basis. The lower percentage increase in customer bills relative to rates is due to the higher amounts of energy efficiency and BTM PV adopted by bundled service customers in the SCE Preferred Portfolio. Moreover, as mentioned earlier, electric rates and bills should not be the sole focus of customer impact analyses. The increased electrification of other sectors in SCE's plan will reduce customers' expenditures on fossil fuel-based resources. For instance, SCE estimates that, under its Pathway approach, customers will save on average $15 per month on a nominal basis and $11 per month on a real basis on gasoline relative to the Baseline case.

Table III-9
Revenue Requirement Components – SCE Preferred Portfolio (2016$)[101]

Cost category (2016$)	2030
Distribution	5,299,103
Transmission	1,241,178
Generation	4,698,769
Demand-side Programs	394,882
Other	3,744
Baseline Revenue Requirement	11,673,677
System Average Rate (2016$ cents/kWh)	**20.4**

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[101] Based on the revenue requirement components in the Proposed Reference System Plan. *See Proposed Reference System Plan*, September 18, 2017, at 46.

Table III-10
Estimated Revenue Requirement and Rates for SCE Preferred Portfolio

Difference: 2030	Baseline	Preferred Portfolio (change from baseline)	Change from baseline %
System Revenue Requirement (Nominal $000)	$16,291,516	($749,406)	-5%
Bundled Revenue Requirement (Nominal $000)	$13,715,491	($2,031,854)	-15%
Bundled Sales (GWh)	59,874	(16,966)	-28%
System Average Rate (Nominal cents/kWh)	22.9	4.3	19%
Residential Customer Bills (Nominal $/month)	$137	$13	9%
System Average Rate ($2016 cents/kWh)	**17.2**	**3.2**	**19%**
Residential Customer Bills ($2016/month)	**$103**	**$10**	**9%**

3.   SCE Preferred Portfolio – Deviations from Current Resource Plans

The SCE Preferred Portfolio assumes substantial adoption of supply- and demand-side carbon-free resources. Various existing resource plans and programs account for procurement and customer adoption of these resources, and may, for the foreseeable future, continue to facilitate SCE achieving GHG reduction while minimizing impacts on customers' bills.

This section briefly describes currently filed and authorized programs that support the SCE Preferred Portfolio within the main categories of: (1) large-scale and traditional generation resources; (2) energy storage; (3) demand-side resources; and (4) transportation electrification. This section also addresses where the SCE Preferred Portfolio deviates from existing resource plans and programs.

a) Large-Scale and Traditional Generation Resources

(1) RPS Procurement Plan

Current Resource Plan

SCE's 2018 RPS Procurement Plan is currently under development and is scheduled to be submitted by August 20, 2018. The Commission approved SCE's 2017 RPS Procurement Plan in D.17-12-007. In particular, the Commission authorized SCE not to hold a 2017 RPS solicitation, and required SCE to seek Commission permission to procure any RPS resources, other than those separately mandated by the Commission, during the time period covered by the 2017 solicitation cycle.[102] SCE's 2017 RPS Procurement Plan showed that SCE expected to be long with respect to its RPS requirements through at least 2029,[103] due to departing load considerations and its RPS bank.

The Commission also authorized SCE to conduct solicitations for short-term (five years or less) sales of RPS resources.[104] To date, SCE has not conducted such a solicitation due, in part, to uncertainty surrounding the outcome of PCIA reform and the effects of that outcome on SCE's RPS need and RPS bank. SCE plans to request authorization to sell RPS resources again in its 2018 RPS Procurement Plan, but will vary its solicitation strategy depending on the outcome of PCIA reform.

Preferred Portfolio Deviation from Current Resource Plan

The SCE Preferred Portfolio includes significant renewable resource additions beyond what is required for RPS compliance, for the purposes of electric sector decarbonization and facilitating achievement of California's 2030 GHG emissions goal. However, RPS Procurement Plans and IRPs have different objectives. The RPS Procurement Plan represents a compliance

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[102] *See* D.17-12-007 at OP 8.

[103] *See id.* at 28 (noting that using Commission assumptions, it is possible as of the time of SCE's draft plan filing that it may have a net short position in 2030; however, using SCE assumptions, it projects to have a net long position through the 2030 compliance period).

[104] *See id.* at OP 8.

"floor." Additional renewable resource procurement will be needed to reach the state's overall climate goals. Therefore, SCE does not believe the SCE Preferred Portfolio includes any overall policy deviation from SCE's last RPS Procurement Plan.

(2) Bundled Procurement Plan

Current Resource Plan

In accordance with D.15-10-031, on January 20, 2016, SCE submitted its Assembly Bill ("AB") 57 Conformed 2014 Bundled Procurement Plan ("2014 Conformed BPP") compliance filing for 2015 through 2024 via Advice Letter 3349-E. The 2014 Conformed BPP was approved on February 16, 2016, and sets the upfront standards and criteria to determine the eligibility of SCE's power procurement transactions for rate recovery prior to execution of the transactions. The ratable rates and position limits, products, transactional processes, and other rules described in SCE's 2014 Conformed BPP represent the upfront standards and criteria that establish SCE's pre-approved authority to procure to meet its bundled service customers' needs.

Preferred Portfolio Deviation from Current Resource Plan

SCE does not believe its SCE Preferred Portfolio deviates from the 2014 Conformed BPP. Bundled Procurement Plans and IRPs also have different purposes. Bundled Procurement Plans are focused on the upfront standards and criteria for rate recovery of shorter term transactions (under five years) to meet bundled service customers' needs. The IRP is intended to address long-term resource planning to ensure system reliability and achieve California's climate and other goals.

(3) Other Contract and Procurement Considerations

SCE proposes no specific changes to its other large-scale procurement plans as part of the IRP process. The SCE Preferred Portfolio maintains the assumption included in the Commission's Reference System Plan that no additional natural gas plants will be retired, beyond OTC plants that are already scheduled for closure. SCE also proposes no new natural gas plants in this IRP. As discussed below, there are some issues not addressed within specific

procurement plans that are before the Commission for its consideration, specifically pertaining to termination of geothermal contracts and combined heat and power ("CHP") procurement.

(a)   Geothermal Contracts

On March 19, 2018, SCE filed an application for authorization to terminate its contracts with Coso Geothermal Power Holdings LLC ("Coso") for a combined 181 MW of geothermal capacity, including 120 MW currently online and 61 MW of additional capacity slated to begin deliveries in 2019.[105] The capacity represented by these contracts is currently included in SCE's baseline of existing contracted capacity for IRP purposes because the Commission has not yet approved these terminations. SCE has requested Commission approval of the Coso termination agreement by November 29, 2018, which is after the filing date for SCE's IRP. The Coso termination agreement will terminate if the Commission does not approve it by December 31, 2018. If the Commission approves the termination of the Coso contracts, SCE will remove them from its baseline resources in subsequent IRP cycles

(b)   CHP Procurement

SCE procures electricity from CHP facilities pursuant to D.10-12-035, which adopted a settlement agreement between the IOUs, CHP trade representatives, and ratepayer advocacy groups. D.10-12-035 set two different types of targets for two different program periods – the Initial Program Period and the Second Program Period.[106]

The Commission set a 3,000 MW target for IOU procurement over the Initial Program Period, and SCE was responsible for procuring approximately 1,400 MW of the total target.[107]

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[105] *See Application of Southern California Edison Company (U 338-E) for Approval of the Coso Termination Agreement*, A.18-03-010, March 19, 2018.

[106] *See D.10-12-035 at 13-18.*

[107] *See CHP Program Settlement Agreement Term Sheet*, adopted in D.10-12-035, October 8, 2010, at Section 2.2.2, available at: http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/124875.PDF.

SCE has already executed contracts and received Commission approval for 1,409 MW, thereby meeting its target.

During the Second Program Period, the Commission set a GHG emissions reduction target of 4.8 MMT by 2020.[108] "[T]he Commission recognized that this Second Program Period target could be adjusted in the [Long-term Procurement Plan ("LTPP") proceeding."[109] In the 2014 LTPP proceeding, the Commission reduced the 4.8 MMT GHG emissions reduction target to 2.72 MMT, of which SCE's share was 1.22 MMT.[110] At an August 25, 2016 meet and confer, SCE's share of the target was adjusted to 1.23 MMT to account for closures of CHP facilities during the Initial Program Period. SCE has held three CHP RFOs during the Second Program Period, and intends to conduct one additional CHP RFO in 2019. SCE has signed contracts that have either been approved or are pending approval[111] with the Commission that would result in 0.885 MMT of GHG emissions reductions. SCE still needs to obtain contracts for 0.345 MMT of GHG emissions reductions in order to meet SCE's GHG emissions reduction target.

All CHP contracts currently in effect are assumed to remain in place for their scheduled duration. The SCE Preferred Portfolio selects no additional CHP resources; however, to the extent SCE must procure additional CHP resources to comply with Commission decisions, it will continue to do so.

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[108] *See* D.10-12-035 at 16-18.
[109] D.15-06-028 at 8.
[110] *See id*. at OP 1.
[111] The following two SCE advice letters for CHP GHG emissions reductions are still awaiting Commission approval: (1) Advice 3769-E for operation of California State University Channel Islands; and (2) Advice 3752-E for closure of Corona Energy Partners.

b)   **Energy Storage**

Current Resource Plans

SCE's most recent Energy Storage Procurement and Investment Plan ("ESP&IP") was submitted on March 1, 2018.[112] To meet the energy storage development targets adopted by the Commission pursuant to AB 2514 and the distributed storage programs and investments opportunity provided by AB 2868, SCE has proposed to procure incremental energy storage resources. Additionally, SCE's 2018 ESP&IP: (1) tracked SCE's progress toward its cumulative AB 2514 580 MW target, as well as the specific grid domain targets; (2) proposed a customer program and utility investment, pursuant to AB 2868; and (3) captured additional storage activities undertaken by SCE.

SCE also filed a procurement plan (Advice 3785-E) to meet the requirements of SB 801 to procure energy storage resources to help address potential reliability challenges resulting from limited operations at the Aliso Canyon natural gas storage facility. Commission staff subsequently issued draft Resolution E-4937, which approves SCE's SB 801 procurement plan to procure an aggregate minimum 20 MW of storage.

Preferred Portfolio Deviation from Current Resource Plans

Although the SCE Preferred Portfolio includes a substantial increase in energy storage capacity above existing contracts and mandates – 1,586 MW by 2030, it is not in conflict with SCE's 2018 ESP&IP. Energy storage is an essential component of meeting California's 2030 GHG emissions target. As GHG constraints become binding in the later part of the planning period, the state will need to reduce renewable curtailment and shift this generation to be used where a GHG-emitting load following resource would have previously been deployed. Energy storage can serve this function.

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[112] *See Application of Southern California Edison Company (U 338-E) in Support of its 2018 Energy Storage Procurement and Investment Plan*, A.18-03-002, March 1, 2018.

Although SCE is not proposing to procure the energy storage in the SCE Preferred Portfolio in this IRP cycle, SCE recommends that the Commission adopt a reliability threshold mechanism that provides for the expedited procurement and deployment of flexible energy storage resources to address system and/or local reliability issues that may arise. This proposal is discussed in Sections I.C.4 and IV.C. SCE will also continue to propose energy storage procurement in response to existing or future mandates as required, via its biennial ESP&IP or as otherwise directed by the Commission.

c) Demand-side Resources

(1) Energy Efficiency

Current Resource Plans

SCE files two relevant energy efficiency program plans – the Energy Efficiency Business Plan and the Energy Savings Assistance ("ESA") Program Plan

Energy Efficiency Business Plan ("Business Plan")

SCE's recent energy efficiency rolling portfolio business plan application was filed in A.17-01-013.[113] The application requests approval of annual budgets and estimated savings for 2018-2025. The requested budget and estimated savings in the Business Plan are included in Table III-11 below.[114]

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[113] *See Southern California Edison Company's (U 338-E) Amended Energy Efficiency Rolling Portfolio Business Plan Application 17-01-013,* A.17-01-013, February 10, 2017.
[114] *See id.*, Attachment 1 at I-5-I-8.

Table III-11
Requested Annual Budget and Estimated Incremental Savings as Presented in A.17-01-013

Year	2018	2019	2020	2021	2022	2023	2024	2025
Requested budget (million)	$250.3	$270.6	$289.1	$284.1	$292.0	$300.3	$308.7	$317.5
Estimated savings (GWh)	1,133.4	1,172.0	1,189.9	1,114.5	1,101.6	1,079.8	1,087.6	1,120.3
Estimated savings (MW)	264.4	281.1	292.5	281.5	281.7	282.1	284.7	293.3

In D.18-05-041, the Commission approved SCE's Business Plan and the associated budget request.[115] The Business Plan was designed to meet the 2015-2025 *Energy Efficiency Potential and Goals Study*. However, updates to the goals were adopted by the Commission after SCE's Business Plan was filed. As such, SCE's actual energy efficiency portfolio savings will reflect values other than what is presented above.

In addition, adopted goals can differ from program performance when changes to energy efficiency policies occur between *Energy Efficiency Potential and Goals Study* updates (every two years), such as measures becoming disallowed or programs being cancelled due to low cost-effectiveness. However, the Business Plans are designed to be flexible to accommodate such variations and will be trued up through the Annual Budget Advice Letter to be filed every September 1.

The 2017 IEPR report supporting energy efficiency inputs informs the IRP modeling account of the latest information and goals from energy efficiency's rolling portfolio process, including the latest energy efficiency goals adopted in D.17-09-025.

ESA Program

In addition to the savings estimated in the Business Plan, SCE also maintains the ESA Program to support energy efficiency improvements for low income customers. The most recent revised budget requests and savings estimates for this program extend through 2020.

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[115] *See* D.18-05-041 at OP 12.

<div align="center">

Table III-12
Proposed Annual ESA Program Budget[116]

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Year	2018	2019	2020
Requested budget (million, approximated)	$111.0	$111.9	$113.5
Estimated savings (GWh)	53.6	49.7	48.1

<div align="center">

Preferred Portfolio Deviation from Current Resource Plans

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The SCE Preferred Portfolio assumes SB 350's statutory requirements regarding two times AAEE are met within SCE's service area. In alignment with the Commission's modeling methodologies, energy efficiency is not a selectable resource, rather it is an assumed load modifier. Estimates of energy efficiency resources at the service area level as load modifiers are as follows in Table III-13.

<div align="center">

Table III-13
SCE Preferred Portfolio Assumed Energy Efficiency in SCE's Service Area[117]

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Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Estimated cumulative savings (GWh)	1,217	2,333	3,467	4,656	5,929	7,260	8,573	10,025	11,484	13,057	14,620	16,173	17,710
Estimated annual incremental savings (GWh)	1,217	1,116	1,134	1,189	1,273	1,332	1,313	1,452	1,459	1,572	1,563	1,553	1,537

SCE does not propose additional energy efficiency budgetary authority in this IRP to achieve the modeled savings levels for several reasons. First, although better alignment among proceedings should be a future goal of the IRP, as of now, energy efficiency programs and budgets continue to be developed in separate proceedings. While the Commission and parties are still considering methodologies to integrate DERs as selectable resources in IRP modeling, these proceedings will likely remain separate in the immediate future. SCE believes considering changes to its Business Plan in the current open proceeding is more appropriate. Second, as

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[116] *See* Advice Letter 3743-E at 6, Attachment 1.

[117] Energy efficiency is reported at the distribution service area level rather than bundled customer level, for consistency with reporting in SCE's Business Plan and ESA Program.

modeled load modifiers, the estimated energy efficiency savings included in the SCE Preferred

Portfolio would likely not all result from IOU customer facing programs. Additional examples

identified by the CEC[118] as measures that could contribute to the two times AAEE goal include

savings that may be procured via other programs and mandates, such as Property Assessed Clean

Energy financing projects[119] or Conservation Voltage Reduction.

(2)   Demand Response

Current Resource Plan

SCE's most recent demand response application (A.17-01-018) was adopted with

modifications in D.17-12-003. In total, SCE's proposed portfolio expects to achieve

approximately 1,000 MW per year of demand reduction from various sources in 2018-2022,

although specific annual targets vary, per Table III-14 below.[120] The budget approved to achieve

these target adoptions was modified from what was originally proposed in D.17-12-003,

resulting in a total of $751.027 million for 2018-2022.[121]

Table III-14
Annual Demand Response Demand Reduction Expected (Across Multiple Programs)

Year	2018	2019	2020	2021	2022
MW expected *(ex ante)*	1,066	1,042	1,024	1,007	991

Preferred Portfolio Deviation from Current Resource Plan

The demand response capacity outlined in SCE's application exceeds what is included in

the SCE Preferred Portfolio; however, this is largely due to differences inherent in modeling and

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[118] *See* CEC, *Staff Paper, Framework for Establishing the Senate Bill 350 Energy Efficiency Savings Doubling Targets*, January 207, available at:
https://efiling.energy.ca.gov/getdocument.aspx?tn=215437.
[119] Property Assessed Clean Energy, enabled primarily through AB 811, allows property owners to finance the cost of energy efficiency projects and repay the loan through a special assessment district on the owner's property tax bill.
[120] *See* D.17-12-003 at 11-12.
[121] *See id.* at 136-137.

reporting on SCE's bundled portfolio. The RESOLVE model includes 1,019 MW of "shed" demand response in its baseline resources, consistent with SCE's demand response programs that cover its full distribution service area. The SCE Preferred Portfolio reflects SCE's estimate of the demand response resources available in its bundled portfolio, after accounting for load departure to CCAs and ESP providers.[122] In line with SCE's demand response application, the bundled portfolio does not propose to procure incremental "shed" demand response resources. SCE's portfolio does not yet examine other forms of demand response that may be deployed.

d) Transportation Electrification

Current Plans

In recent years, SCE has enabled charging station growth through development of "make-ready" EV charging station infrastructure. Beginning in 2014, SCE has been active in developing pilots and programs to support California's policies to reduce GHG and air pollutant emissions and to help meet the state's ZEV goals.

On May 31, 2018, the Commission granted SCE approval for a medium- and heavy-duty EV program, to facilitate 870 "make ready" charging installations contracted by 2024, supporting 8,490 additional EVs.[123] On January 11, 2018, the Commission granted approval for several of SCE's Priority Review Projects that would enable testing and data collection on several smaller-scale initiatives such as residential charging station rebates, port of Long Beach electrification initiatives, urban fast charging clusters, and an electric transit bus charging program.[124]

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[122] SCE utilized CAM, GAM, and PMM factors to represent CCA impacts to the anticipated demand response portfolio consistent with other supply-side inputs in the SCE Preferred Portfolio. In reality, there may be less reduction in the remaining demand response in SCE's portfolio from resource departure than modeled, given demand response program characteristics and rules around departing load allocation. SCE plans to explore the effect of these characteristics and rules to the IRP modeled portfolio mix more completely in future IRPs.

[123] *See* D.18-05-040 at OP 32.

[124] *See* D.18-01-024 at OP 17.

On June 26, 2018, SCE submitted its application for the Charge Ready 2 Infrastructure and Market Education Programs following the success of SCE's Charge Ready light-duty EV pilot.[125] The proposed program largely follows the "make-ready" model used in the pilot, but also includes new options primarily for multi-unit dwellings. SCE is proposing a four-year, $760 million program to support up to 48,000 charge ports in SCE's service area. The proposal will help put the state on the path to reach the 7 million EVs outlined in SCE's Pathway as needed to meet California's GHG emissions and air quality goals.

Preferred Portfolio Deviation from Current Plans

SCE's IRP does not propose any additional transportation electrification initiatives incremental to what has been proposed to the Commission in other proceedings and applications. Transportation electrification program proposals and requests will, for the time being, be submitted outside the IRP proceeding, as in SCE's recent Charge Ready 2 application.

The SCE Preferred Portfolio includes substantially more transportation electrification load than currently exists in SCE's service area. SCE estimates that 7 million EVs need to be on California's roads for the state to meet its 2030 GHG emissions goal. For SCE's bundled load, this target translates to a total transportation electrification load of 6,834 GWh. SCE's current and proposed transportation electrification programs are working toward enabling these goals, but more action may be necessary in the future to fully realize this level of transportation electrification.

4.   SCE Preferred Portfolio – Local Needs Analysis

Given all non-OTC natural gas plants are assumed to remain operational throughout the IRP planning period, there is sufficient capacity to meet the local capacity needs of the Los Angeles Basin local reliability area. The CAISO's *2019 Local Capacity Technical Analysis*, which covers 2019-2023, provides a current assessment of the minimum capacity required to

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[125] *See Application of Southern California Edison Company (U 338-E) for Approval of its Charge Ready 2 Infrastructure and Market Education Programs*, A.18-06-015, June 26, 2018.

maintain reliability in the Los Angeles Basin local reliability area and has not identified deficiencies.[126]

In D.13-02-015, the Commission authorized SCE to procure capacity to meet LCR needs in the Western Los Angeles sub-area of the Los Angeles Basin local reliability area and the Moorpark sub-area of the Big Creek/Ventura local reliability area. In D.16-05-050, the Commission approved, in part, the results of SCE's LCR RFO for the Moorpark sub-area, including the contract for the 262 MW Puente project. However, on October 5, 2017, the CEC Siting Committee assigned to the certification of the Puente project provided notice of its intent to issue a Presiding Member's proposed decision recommending denial of certification of the Puente project. The CEC permitting process for the Puente project has since been suspended. Accordingly, with Commission oversight, SCE launched the Moorpark LCR/Goleta Resiliency RFP on February 28, 2018 to address the resulting LCR shortfall in the Moorpark sub-area.

However, the CAISO has not yet assessed the effects of a deep decarbonization, high electrification case, such as the SCE Pathway System Plan, on local capacity needs. Nor has the CAISO fully studied the local reliability impacts of reductions in revenue for natural gas plants and the potential economic retirements of such plants or the local reliability effects of the continuing restrictions on use of the Aliso Canyon natural gas storage facility and natural gas pipeline constraints. SCE recommends that the Commission request that the CAISO study these issues in the 2019-2020 TPP as addressed in Sections I.C.3 and IV.A.2.

Finally, SCE proposes that the Commission adopt a reliability threshold mechanism that would allow for expedited procurement and fast deployment of flexible energy storage resources if local (or system) reliability issues arise before a decision is issued in the next IRP cycle. This proposal is explained in Sections I.C.4 and IV.C.

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[126] *See* CAISO, *2019 Local Capacity Technical Analysis, Draft Report and Study Results*, April 23, 2018, at 59, available at: http://www.caiso.com/Documents/Draft2019LocalCapacityTechnicalReport.pdf.

C. SCE Conforming Portfolio

In accordance with D.18-02-018, the SCE Conforming Portfolio is based on inputs and assumptions from the Commission's Reference System Plan and the 2017 IEPR. Consistent with current Commission decisions, the SCE Conforming Portfolio also assumes the PCIA methodology will remain in place. Based on those assumptions, the SCE Conforming Portfolio shows no resource additions through 2030.

1. SCE Conforming Portfolio – GHG Emissions and Local Air Pollutant Minimization

The SCE Conforming Portfolio was developed to meet SCE's Commission-established 2030 GHG emissions benchmark of 9.397 MMT.[127] As with the SCE Preferred Portfolio, SCE set targets for each intervening year between 2018 and 2030 via straight-line reduction. SCE also used the Commission's CNS methodology and CNS Calculator to measure expected emissions attributable to the SCE Conforming Portfolio. For NOx and PM2.5 emissions, SCE used the same modified CNS Calculator tool it used to measure SCE Preferred Portfolio emissions to measure SCE Conforming Portfolio emissions. This approach is discussed in Section III.B.1.a and Appendix F.

As shown in Table III-15 below, the SCE Conforming Portfolio's 2030 emissions are 7.5 MMT, which is well below SCE's 2030 GHG emissions benchmark of 9.397 MMT. GHG, NOx, and PM2.5 emissions are all reduced compared to current levels.[128]

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[127] *See Administrative Law Judge's Ruling Finalizing Load Forecasts and Greenhouse Gas Benchmarks for Individual Integrated Resource Plan Filings*, R.16-02-007, June 18, 2018, at 4.

[128] SCE's CNS Calculators for the SCE Conforming Portfolio are included as Appendix I.1, CNS Calculator (GHG) – SCE Conforming Portfolio; Appendix I.2, CNS Calculator (NOx) – SCE Conforming Portfolio; and Appendix I.3, CNS Calculator (PM2.5) – SCE Conforming Portfolio.

Table III-15
SCE Conforming Portfolio CNS Calculator Emissions Results

Emissions type (units)	2018	2022	2026	2030
GHG (MMT)	13.8	7.6	7.2	7.5
PM2.5 (metric tons)	728	381	390	380
NOx (metric tons)	1,440	960	943	966
% change from 2018				
GHG		-45%	-48%	-46%
PM2.5		-48%	-46%	-48%
NOx		-34%	-35%	-33%

Although the SCE Conforming Portfolio does not show a need for any resource additions through 2030, to the extent SCE does any procurement, it would follow the same procurement practices and evaluation criteria discussed in Section III.B.1.b.2. SCE also plans to evaluate the potential for EGT retrofits at its three remaining peaker plants and continue its efforts to facilitate transportation electrification as discussed in Sections III.B.1.b.3 and III.B.1.b.4. Moreover, the information on DACs in SCE's service area and current and planned programs and activities impacting DACs in Sections III.B.1.c and III.B.1.d and Appendix H are the same for the SCE Preferred and Conforming Portfolios.

2.   **SCE Conforming Portfolio – Cost, Rate, and Customer Bill Analysis**

SCE's revenue and rates forecast of the SCE Conforming Portfolio reflects the SCE Conforming Portfolio study results in Section III.A.1.c, and the load and system assumptions summarized in Table II-5 in the assumptions discussion in Section II.B.4. Additionally, as stated in Section III.B.2 with respect to the SCE Preferred Portfolio, SCE used internal RPS contract pricing and costs to model existing RPS contracts in the SCE Conforming Portfolio, rather than the costs provided in RESOLVE. SCE's use of internal RPS contract costs more accurately reflects the costs from these contracts through 2030.

SCE's Baseline revenue and rates forecast and assumptions are discussed in Section III.B.2.a. Consistent with this Baseline analysis, the SCE Conforming Portfolio cost analysis assumes no change to the current PCIA methodology, and includes revenue for SCE's approved transportation electrification programs. It does not, however, include the recently filed Charge Ready 2 application. The SCE Conforming Portfolio assumes a level of energy efficiency that is higher than SCE's Baseline forecast, but not as high as in the SCE Preferred Portfolio.

These factors together result in a modest system average rate increase over the Baseline in 2030 – an approximate 0.8 cents per kWh nominal increase or 0.6 cents per kWh real increase over SCE's 2030 Baseline rate. Additionally, SCE estimates that in 2030, there is no estimated change in residential customer bills for the SCE Conforming Portfolio relative to the Baseline forecast. These results are unsurprising given that SCE forecasts no renewable or energy storage resource additions in the SCE Conforming Portfolio and the bundled load forecasts are similar between SCE's Baseline and SCE Conforming Portfolio revenue and rates forecasts. Additionally, the Baseline forecast includes higher EV adoption than what is assumed in the SCE Conforming Portfolio; therefore, there are no estimated gasoline expenditure savings for the SCE Conforming Portfolio.

Table III-16
Revenue Requirement Components – SCE Conforming Portfolio (2016$)[129]

Cost category (2016$)	2030
Distribution	5,623,828
Transmission	1,241,178
Generation	5,133,980
Demand-side Programs	350,330
Other	3,744
Baseline Revenue Requirement	12,353,060
System Average Rate (2016$ cents/kWh)	**17.7**

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[129] Based on the revenue requirement components in the Proposed Reference System Plan. *See Proposed Reference System Plan*, September 18, 2017, at 46.

Difference: 2030	Baseline	Conforming	Change
System Revenue Requirement (Nominal $000)	$16,291,516	$205,987	1%
Bundled Revenue Requirement (Nominal $000)	$13,715,491	($1,012,184)	-7%
Bundled Sales (GWh)	59,874	(6,214)	-10%
System Average Rate (Nominal cents/kWh)	22.9	0.8	3%
Residential Customer Bills (Nominal $/month)	$137	$0	0%
System Average Rate ($2016 cents/kWh)	**17.2**	**0.6**	**3%**
Residential Customer Bills ($2016 /month)	**$103**	**$0**	**0%**

3. SCE Conforming Portfolio – Deviations from Current Resource Plans

SCE's current resource plans and programs are discussed in Section III.B.3. The SCE Conforming Portfolio reflects no capacity additions through 2030. SCE will continue to meet its statutory and regulatory requirements for individual resource procurement, and follow its existing procurement plans in the event the Commission selects the SCE Conforming Portfolio for the 2017-2018 IRP cycle. SCE does not believe the SCE Conforming Portfolio will deviate from its existing resource plans. Future cycles of the IRP should inform resource procurement and program planning for supply- and demand-side resources.

4. SCE Conforming Portfolio – Local Needs Analysis

SCE's concerns as addressed in Section III.B.4 for the SCE Preferred Portfolio are the same for the SCE Conforming Portfolio.

IV.

ACTION PLAN

A.   **SCE Preferred Portfolio – Action Plan**

1.   **Resource Procurement**

a)   **Proposed Activities**

As shown Figure III-9 in Section III.A.1.b, the SCE Preferred Portfolio has 764 MW of renewable resources additions starting in 2022, increasing to a cumulative 2,218 MW of renewable resource additions by 2024. The timing of the resource additions in this 2022-2024 time period is driven by economics. In 2025 and later years, resources are selected to meet the more stringent GHG emissions constraints in SCE's Pathway scenario as such constraints become binding. The SCE Preferred Portfolio selects cumulative renewable resource additions of 4,244 MW by 2030, along with 1,586 MW of battery storage added in 2029-2030. This level of resource additions is what is needed for SCE's bundled customer base in support of the overall need for the electric sector to reach GHG emissions of 28 MMT by 2030 economically.

As discussed in Section I.C.1, SCE is ready to begin procurement under the SCE Preferred Portfolio to support deeper decarbonization, but two conditions must be met: (1) adoption of a 2030 electric sector GHG emissions planning target of 28-30 MMT[130] and higher electrification assumptions consistent with SCE's Pathway for all LSEs filing IRPs;[131] and (2) adoption of the IOUs' GAM/PMM proposal to replace the PCIA methodology or a similar

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[130] As explained in footnote 3, given that the Commission may not have authority to establish targets for its jurisdictional LSEs that are below the lower bound of the range established by CARB, SCE's request is for 28 MMT to 30 MMT, the lower bound of CARB's range.

[131] If the Commission adopted a 2030 electric sector GHG emissions planning target of 30 MMT, some adjustments to the SCE Preferred Portfolio would be needed as it was based on a 28 MMT target.

equitable departing load cost allocation mechanism.[132] Until these two conditions are met, SCE will procure under the SCE Conforming Portfolio as provided in Section IV.B.

(1)   **Procurement of Renewable Resource in Technology Agnostic Competitive Solicitations**

SCE's modeled annual renewable capacity additions in the SCE Preferred Portfolio are shown in Table IV-18 below.

Table IV-18
SCE Preferred Portfolio Annual Renewable Capacity Additions

Incremental (MW)	2022	2023	2024	2025	2026	2027	2028	2029	2030
Geothermal				46	227	370	105		139
Solar	764		801					197	275
Wind		654					550	118	
Total Renewables	764	654	801	46	227	370	655	315	414

If the input assumptions for prices and resource availability hold true, this schedule reflects one of many optimized portfolios, which SCE intends to use as a guide for cost-effective renewable resource procurement from 2022 through 2030. However, commercial reality and market options that are available when a solicitation is conducted may deviate from the model assumptions and the modeled outcome. Imposing specific procurement targets or technology buckets may inhibit SCE's ability to bring significant amounts of renewable capacity online in a cost-effective manner. The amount of a specific technology selected in the model may not be available in the modeled years, or the modeled project costs may not reflect market conditions in a given year. Therefore, any procurement authorization resulting from this and future IRPs should be done through competitive, technology agnostic solicitations, and may deviate from the modeled optimal portfolio shown above. This approach is consistent with past RPS solicitations,

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[132] Even if the Commission adopts the IOUs' GAM/PMM proposal with modifications or an equitable departing load cost allocation mechanism similar to GAM/PMM, some adjustments to the SCE Preferred Portfolio would be necessary.

where SCE solicited for all renewable resources, and provides appropriate optionality should prices either prove competitive or uncompetitive relative to expectations, or the availability of resources deviate from model inputs.

(2) Procurement Timing Flexibility

Using the model optimized buildout in the SCE Preferred Portfolio as a guide, SCE recommends that it be given the option to distribute procurement between 2022 and 2030. This improves the likelihood that the proposed resources will come online in the most cost-effective and efficient manner, thereby minimizing customer cost impacts while still working to achieve GHG emissions targets. The ability to distribute procurement over more than one solicitation can better account for market constraints that may result in higher than anticipated prices. There are three important benefits of this flexible approach: (1) minimizing interconnection process risk; (2) improving optionality; and (3) reducing commercial development risk.

Minimizing Interconnection Process Risk. Distributing procurement over multiple years helps minimize interconnection process constraints. Each local distribution company ("LDC") has finite staff and equipment that it can dedicate to constructing network upgrades and interconnecting facilities each year, given its other ongoing transmission and distribution repair and maintenance work. Since this work is managed concurrently, procuring large quantities of resources in one year may result in interconnection process delays, especially if multiple LSEs have overlapping procurement needs in one LDC's service area. To the extent SCE can account for interconnection process constraints in its planning and procurement, it becomes more likely that SCE's procured resources can achieve their commercial online date targets.

Improving Optionality. Flexibly distributing procurement over a longer period affords SCE increased optionality to procure higher quantities when solicitations return competitive prices (or less when prices are higher than expected). Conversely, if SCE is held to yearly targets in line with its modeled portfolios, SCE may have to procure at higher prices in a given

year, if the market yields a less competitive solicitation or unexpectedly high prices. To optimally procure the SCE Preferred Portfolio, SCE should be given procurement flexibility to procure more or less than the modeled capacity additions in a given year, if pricing is competitive.

Reducing Commercial Development Risk. Spreading procurement across multiple years may also mitigate commercial development risk. To address the likelihood that some procured resources will be delayed past their commercial online dates, or default entirely, SCE should procure more resources overall than the forecast additions in its SCE Preferred Portfolio. Flexibility to procure more in early years if pricing proves competitive will mitigate the potential cost impacts of project delays or failures on SCE's bundled service customers.

b) **Barrier Analysis**

To protect the financial interests of its bundled service customers, SCE cannot initiate procurement pursuant to the SCE Preferred Portfolio until two barriers are overcome – adoption of 28-30 MMT GHG emissions planning target for the electric sector under a cross-sector high electrification scenario, and overhaul of current PCIA mechanism to eliminate unjust cost shifts.

Until such time as the Commission adopts this approach for all LSEs in the IRP process, it would not be in the best interests of SCE's bundled service customers for SCE alone to procure in accordance with the SCE Preferred Portfolio. To alleviate this barrier, the Commission should adopt a cross-sector approach with higher electrification and a more stringent GHG emissions planning target that represents deeper levels of decarbonization in the electric sector in line with SCE's Pathway.

As of the date of this filing, a decision has not yet been issued on PCIA reform in R.17-06-026. The SCE Preferred Portfolio assumes adoption of the IOUs' GAM/PMM proposal; therefore, SCE's procurement needs would change if GAM/PMM is not adopted. Additionally, an equitable cost allocation mechanism for departing load charges is needed to enable the long-term procurement required to achieve California's 2030 GHG emissions goal.

Otherwise, procuring renewables under the SCE Preferred Portfolio would only exacerbate unlawful cost shifts to SCE's bundled service customers.

If the Commission does not adopt the deep decarbonization target for all LSEs, and if GAM/PMM or a similar equitable departing load cost allocation mechanism is not adopted, SCE intends to pursue procurement in accordance with the SCE Conforming Portfolio and requests that the Pathway approach be revisited in the 2019-2020 IRP cycle.

c) **Proposed Commission Direction**

(1) **Procurement Authorization for Renewable Resources**

If the two conditions for SCE pursuing procurement under the SCE Preferred Portfolio are met, SCE requests authority to conduct annual, technology agnostic competitive solicitations in 2019-2021 to procure the renewable resources coming online in the SCE Preferred Portfolio from 2022-2024. The Commission should authorize up to 2,219 MW of procurement (representing the total cumulative capacity additions modeled in the SCE Preferred Portfolio from 2022-2024), in order to provide optionality to procure more or less capacity based on available resources. The Commission should allow SCE to choose to hold an annual solicitation in each year from 2019 to 2021, but decline to procure in any of those years if pricing proves uncompetitive. SCE should also be given the flexibility to procure part or all of the capacity in one procurement cycle if pricing is highly competitive, up until the total procurement authority limit is reached.

(2) **Solicitation Framework**

SCE requests that the Commission authorize this procurement as part of its approval of SCE's IRP. While SCE intends to conduct competitive solicitations for these resources in a manner similar to its recent RPS solicitations, SCE should not have to seek separate approval within its RPS Procurement Plans since this procurement is not to meet RPS goals. The Commission should authorize SCE to conduct annual competitive solicitations, without

specific yearly targets or technology mandates. The Commission should direct SCE to submit a procurement plan for Energy Division approval prior to each solicitation. This procurement plan should describe SCE's procurement methodology, including details on eligible products, timeline, evaluation approach, including criteria used to evaluate procurement in DACs, how the products will be evaluated in terms of GHG reductions, and Independent Evaluator oversight.

SCE requests that the Commission authorize use of Tier 3 advice letters to approve contracts resulting from these solicitations. SCE's experience in past RPS solicitations shows that utilizing Tier 3 advice letters facilitates faster project development as compared to the application process. Contract approval via Tier 3 advice letters has become standard practice for preferred resource procurement, including renewables, CHP, and DERs.

(3)   Evaluation Approach

SCE intends to use the Commission-approved least-cost, best-fit methodology to evaluate offers from developers for resource procurement. As described previously, the least-cost aspect of the methodology ensures that quantifiable attributes are considered and used to develop an NPV assessment of the proposed offer by subtracting the present value of costs from the present value of realizable benefits. These cost and benefit components include items such as fixed and variable contract payments, transmission and distribution upgrade costs, energy value, and RA value. The best-fit aspect of the methodology allows SCE to consider non-quantifiable attributes of the offer such as viability, location, counterparty concentration, technology preferences, and loading order. As previously stated, the best-fit portion of the methodology also addresses prioritizing bids for preferred resources in DACs.[133] This approach is consistent with evaluations SCE performs in other solicitations, such as CHP RFOs, RPS RFOs, and all source RFOs for energy and RA.

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[133] For more information on SCE's least-cost, best-fit methodology, including SCE's evaluation criteria for resources located in DACs, see Section III.B.1.b.2.

(4) System-Optimized Storage Resources

The SCE Preferred Portfolio shows that approximately 9.6 GW of energy storage will be needed in the CAISO system by 2030, 1.6 GW of which is at the SCE bundled level, to help meet California's 2030 GHG emissions goal. Regardless of the path forward, a significant amount of energy storage will be needed by 2030 to address flexibility needs resulting from natural gas plant retirements and to integrate high penetrations of renewable resources. Early deployment of this energy storage can address near-term reliability concerns,[134] while meeting impending renewables integration needs and improving grid efficiency. Thus, bringing forward energy storage procurement and deployment that is expected to be needed anyway to address near-term reliability issues (e.g., under SCE's reliability threshold mechanism proposal discussed in Sections I.C.4 and IV.C), is a low-regrets opportunity to bridge reliability concerns and promote an early transition away from GHG-emitting resources. While energy storage is able to provide many services, it must be properly located[135] and operated to deliver the full spectrum of potential benefits. Accordingly, SCE urges the Commission to account for the importance of where energy storage resources are located and how they are operated in future procurement need determinations.

Energy storage that is optimally located and operated maximizes its benefits for both customers and the electric grid by most effectively serving both market and grid needs ("System-Optimized Storage Resource"). It has the potential to increase the operational efficiency of the electric grid by improving the performance, and increasing the utilization, of existing transmission and distribution assets, while alleviating congestion. In parallel, it can also be

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[134] Recent examples include SCE's 2013 LCR RFO, SCE's and SDG&E's 2016 energy storage procurement to address operational concerns at the Aliso Canyon natural gas storage facility, and PG&E's recent Local Sub-Area Energy Storage RFO.

[135] In its recent decision on multiple-use application issues regarding energy storage, the Commission identified multiple reliability services that energy storage can provide. *See* D.18-01-003 at 10, OP 1. Within the distribution and transmission domains, nearly all of the reliability services are influenced by their location on the electric grid.

available to serve current and future system needs, such as providing ancillary services and managing renewable energy generation intermittency.

Since the biggest value of energy storage is in its versatility to meet multiple needs under varying conditions, retaining flexibility in how these devices are used and deployed is essential to maximize its value. Therefore, owners and operators of storage resources must be able to understand and act on dynamic market and grid needs so that storage is dispatched to its highest and best use as a cohesive part of ongoing utility operations. Moreover, because energy storage can act as both load and generation depending on its state of charge, it presents unique challenges for system operators and can improve or degrade grid reliability, resiliency, and affordability depending upon where they are located and how they are operated. System-Optimized Storage Resources, when appropriately located through central coordination or planning, and operated with appropriate oversight,[136] can defer or reduce the need for new transmission and distribution assets. On the other hand, poorly-sited energy storage may require additional investments in new capacity or distribution upgrades. While the system can integrate some market-only storage resources without impacting efficient operations, in order to maximize customer value from the deployment of energy storage through both market revenues and grid optimization, System-Optimized Storage Resource deployment should be maximized and explicitly considered in the 2019-2020 IRP process.

2. **Transmission and Reliability**

a) **Proposed Activities**

The SCE Pathway System Plan (and the SCE Preferred Portfolio) allows addition of new generation capacity without triggering the need for significant transmission upgrades. As explained in Section III.A.1.d, the strategic location of resources in areas that can

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[136] System-Optimized Storage Resources should be procured under Commission oversight and operated according to the Standard of Conduct #4. *See* D.02-10-062 at COL 11.

accommodate new resources without transmission upgrades is key. The location of energy storage facilities added in the later part of the planning period also helps to integrate renewable resources and mitigate congestion on existing transmission infrastructure.

Despite this, it is important for the CAISO to study a deep decarbonization, high electrification case like the SCE Pathway System Plan in its 2019-2020 TPP. For California to achieve its 2030 GHG emissions goal while minimizing impacts on customers' bills, it is essential that the TPP conduct a more thorough transmission system adequacy study, and identify any required upgrades or expansions. The CAISO should also consider energy storage as an option for meeting any identified needs. Transmission projects, to the extent they are needed, require long lead times (seven years or more). Conducting a TPP study on the SCE Pathway System Plan as a policy-driven case in the CAISO's 2019-2020 TPP will ensure the Commission and stakeholders have the appropriate information to drive future investment decisions.

The CAISO system currently relies on natural gas plants to provide reliability and renewable integration services, which helps ensure delivery of safe and reliable electric service. However, as the system adds significant additional renewable resources, it is likely that the economic viability of certain natural gas plants will be challenged. SCE is concerned that the Commission has not yet fully evaluated reliability concerns related to natural gas plant retirements in the IRP process.

Indeed, the Commission's Reference System Plan assumes that all natural gas plants will be available for the planning horizon other than the OTC plants scheduled for retirement. The Commission recognized that this assumption was "criticized by many parties" and is a "simplifying assumption that does not necessarily reflect reality."[137] The Commission also stated that examination of impacts on the natural gas fleet in California "is an important policy area for further work."[138] SCE agrees the topic of natural gas retirements needs to be studied

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[137] D.18-02-018 at 145.
[138] *Id.*

further under both the Commission-adopted 42 MMT case and a high renewables, high electrification case, and suggests that such study occur through the CAISO's TPP.

Lastly, natural gas system constraints not considered in the IRP process may affect the ability of the natural gas fleet to meet system and/or local reliability needs. For example, the recent challenges to SoCalGas system deliverability due to the de-rating of the Aliso Canyon natural gas storage facility and other recent unplanned pipeline outages may impair the ability of the system to deliver the needed natural gas for electric generation plants.[139] SCE suggests the Commission also ask the CAISO to study the ability of the natural gas system to meet electric generation plant demand under varying scenarios in its 2019-2020 TPP.

b)   Barrier Analysis

The SCE Preferred Portfolio does not indicate a need for new transmission upgrades during the planning period. If transmission upgrades would become necessary, the cost of those upgrades would be considered within the procurement process. However, SCE reiterates that it is important for the CAISO to conduct a TPP study that examines the transmission impacts of a statewide portfolio with deeper decarbonization and higher electrification levels, in line with the SCE Pathway System Plan.

Unplanned retirement of natural gas plants, delays in the online dates of local capacity resources contracted in past solicitations, and natural gas system constraints could result in system and/or local reliability problems. These potential barriers can be addressed by the CAISO studying these issues in the 2019-2020 TPP, to better understand their potential impact on the electric grid. These issues should also be more thoroughly considered in the next IRP cycle. In the meantime, the Commission should address these potential barriers by approving SCE's proposed reliability threshold mechanism as described in Sections I.C.4 and IV.C.

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[139] *See* Commission, CEC, CAISO, and LADWP, *Aliso Canyon Risk Assessment Technical Report Summer 2018*, May 7, 2018, available at: www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/About_Us/Organization/Divisions/News_and_Outreach_Office/Aliso%20Canyon%20Summer%202018%20Technical%20Assessment.pdf.

This mechanism would allow for expedited procurement and deployment of flexible energy storage resources to address system and/or local reliability issues that may arise.

c)   **Proposed Commission Direction**

As discussed above, CAISO should complete a thorough study of a high renewables, high electrification case like the SCE Pathway System Plan in the TPP to: (1) determine the transmission system impacts of the SCE Pathway System Plan for the entire CAISO footprint; (2) begin discussions to modify or augment generation interconnection or procurement processes to maximize transmission utilization; (3) consider energy storage as an option to meet identified needs (both generation and transmission); and (4) provide the necessary lead time to develop policy-driven transmission lines if required. SCE requests that the Commission forward the SCE Pathway System Plan to the CAISO to study as a policy-driven case in its 2019-2020 TPP.

The Commission should also ask the CAISO to analyze the system and local reliability impacts of reductions in revenue for natural gas plants and the potential economic retirements of such plants under both the Commission's Preferred System Plan and the SCE Pathway System Plan in the CAISO's 2019-2020 TPP. The ability of the natural gas system to meet electric generator gas demand under varying demand and system supply scenarios consistent with these plans should also be included in this analysis. The study should analyze the effects of the continuing restrictions on use of the Aliso Canyon natural gas storage facility and the impacts of pipeline outages on the ability to fill storage facilities to levels sufficient to ensure energy reliability throughout the summer and winter seasons.

As California seeks to reduce reliance on GHG-emitting resources in support of its climate and air quality goals, the state needs to analyze these issues in order to develop a comprehensive transition plan that ensures system reliability is maintained (or enhanced) in the process.

3.   **Transportation Electrification**

a)   **Proposed Activities**

Multiple paths exist for California to meet its 2030, and ultimately 2050, climate goals with varying levels of difficulty and costs. However, all feasible paths for reaching these goals must significantly reduce GHG emissions from the transportation sector. SCE's GHG scenario analysis determined that achieving 7 million EVs on California roads by 2030 is a crucial part of the least-cost strategy for achieving the state's 2030 GHG emissions target. To meet that goal, a sufficient amount of electric fueling infrastructure needs to be built today, and for years to come, to support both EV adoption and fueling. SCE has several approved transportation electrification programs underway, including charging infrastructure "make-ready" investments for light-, medium-, and heavy-duty vehicles, and home charging installation rebates. These programs are described in Section III.B.3.d.

Building upon already-approved pilots, SCE also recently filed its Charge Ready 2 application, A.18-06-015. This program is aimed at accelerating light-duty EV adoption by reducing range anxiety, promoting EV awareness, and increasing grid benefits.

Key elements of Charge Ready 2 include:

- Supporting and accelerating the adoption of light-duty EVs on a trajectory consistent with SCE's Pathway, which identifies a need for 7 million EVs by 2030 to reach California's GHG and air quality goals, and at the same time consistent with being able to at least meet the Governor's call for 5 million EVs by 2030.[140] SCE's Charge Ready 2 proposal transitions the Charge Ready Pilot to a multi-year program, by scaling up certain original Charge Ready Pilot features while also adding new and innovative program components.

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[140] *See* Exec. Order B-48-18 (2018).

- Installing, operating, and maintaining the "make-ready" infrastructure to support 32,000 charge ports, including DCFC, with customer rebates to offset a portion of the chargers' costs, and providing an option for site owners to install and own the customer-side infrastructure for which they would receive a rebate of up to 80% of the costs;

- Creating new options that provide a range of unique solutions for charging needs in the multi-unit dwelling segment: (1) turnkey option with utility ownership/operation of charging stations; (2) new construction rebates that will support up to 16,000 charge ports; and (3) use of infrastructure to support street-side charging;

- Targeting the needs of low-income and state-designated DACs, including a commitment to deploy a minimum of 30% of the Charge Ready 2 program's charging infrastructure in DACs;

- Providing a comprehensive marketing, education and outreach program over a four-year period; and

- Incorporating lessons learned from the Phase 1 Pilot and extending to a four-year program to provide more market certainty to contractors and suppliers, enabling economies of scale to reduce costs.

b) Barrier Analysis

SCE has proposed significant investments in EV infrastructure, to facilitate transportation electrification adoption. However, significant barriers[141] continue to impede this adoption, which would in turn limit SCE's ability to achieve its electrification goals.

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[141] Discussing consumer EV adoption and empirical research, available at: https://www.sciencedirect.com/science/article/pii/S1361920914001515.

Nearly 400,000 EVs are registered in California with over 127,000 of those residing in SCE's service area.[142] EVs represent 5.4% of new vehicle sales in California.[143] While this percentage has consistently increased since 2010, the EV share of new sales needs to grow dramatically through 2030 for California to meet its environmental goals. The high-level barriers – charging availability, awareness, and affordability – have remained persistent, but research[144] is exposing important nuances and a more detailed understanding of these barriers. Many studies,[145] have identified "range anxiety" as a top barrier to EV adoption with several facets contributing to the broader sentiment: access to public charging stations, access to home charging, and range of vehicle. As adoption accelerates, the pace of public charging infrastructure installation needs to significantly accelerate as well, to avoid true range limitations and exacerbating driver "range anxiety."

Further, lack of public awareness regarding EVs and their benefits, and available incentive support, remains a major barrier.[146] A California-specific study for CARB found that 49% of respondents were aware of federal EV incentives, but only 32% were aware of state incentives.[147] Additionally, customers have multiple misconceptions about the performance and reliability of EVs, assuming that gasoline-powered vehicles are more reliable and safer than EVs despite lack of evidence[148] Misunderstanding and lack of knowledge about plug-in hybrid

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[142] As of April 2018, data from the Electric Power Research Institute on annual LDV sales in California, based on registration data obtained through RL Polk, measured at the county level.

[143] *See id.*

[144] Discussion on charging in public, available at: http://www.latimes.com/business/autos/la-fi-hy-agenda-ev-charging-20160920-snap-story.html.

[145] For example, "range anxiety" is scaring people away from EVs, but the fear may be overblown (except for people that do travel more than half of the EV's range on a daily basis), available at: https://www.washingtonpost.com/news/energy-environment/wp/2016/08/15/range-anxiety-scares-people-away-from-electric-cars-why-the-fear-could-be-overblown/?utm_term=.2f2de7104a53.

[146] *See* Mark Singer, National Renewable Energy Laboratory, *Consumer Views on Plug-in Electric Vehicles – National Benchmark Report (Second Edition)*, December 2016, at 11, available at: https://www.nrel.gov/docs/fy17osti/67107.pdf.

[147] *See* Kenneth Kurani et al., *New Car Buyers' Valuation of Zero-Emission Vehicles: California*, March 31, 2016, at 40, available at: https://www.arb.ca.gov/research/apr/past/12-332.pdf.

[148] *See* U.S. Department of Energy, Alternative Fuels Data Center, available at: https://www.afdc.energy.gov/vehicles/electric_maintenance.html.

vehicles and battery EVs may be the most important finding of interviews with customers.[149] Significant actions need to be taken to address this persistent awareness gap.

Expanding transportation electrification will require sustainable policies and collaboration between vehicle manufacturers, charging companies, policymakers, site hosts, and electric utilities on issues such as charging infrastructure deployment and consumer awareness. Without joint commitment and collaboration across many stakeholder groups to resolve these barriers, meeting the level of EV adoption needed by 2030 is at risk.

c) **Proposed Commission Direction**

Although not at issue in this IRP, the Commission should approve transportation electrification programs that reduce EV adoption barriers, such as SCE's proposed Charge Ready 2 program. In particular, increasing electrification in DACs is essential to enable GHG and air pollution emissions reductions from mobile sources, as the electric sector also continues to become cleaner.

More broadly, SCE urges the Commission to adopt an economy-wide perspective when evaluating electric sector GHG emissions planning targets in the IRP process. Without this perspective, the state will miss economical GHG reduction and system management opportunities. For example, in the SCE Pathway System Plan, approximately 16 GW of renewable resources are added to the CAISO system by 2030, with the majority of this being solar. EV customers can help California use abundant renewable power, particularly when they are able to charge during periods of over-generation. Time-of-use ("TOU") price signals[150] and other load management strategies can help shift EV load to hours of the day when there is excess

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[149] *See* Kenneth Kurani et al., *New Car Buyers' Valuation of Zero-Emission Vehicles: California*, March 31, 2016, at 135, available at: https://www.arb.ca.gov/research/apr/past/12-332.pdf.

[150] *See* D.18-07-006 at 9 ("…properly defined TOU periods will provide incentives for customer use and development of future generation that better reflects the state's electric grid. This, in turn, should assist in reaching state energy goals by minimizing costs, reducing [GHG] emissions, encouraging conservation, and increasing the supply of electricity at times that best serve the needs of the grid.").

renewable generation on the grid. At these times, load is less costly to serve, which will ultimately reduce customer costs while reducing GHG emissions. To realize this potential for active, day-time grid management, however, California needs sufficient away-from-home charging infrastructure as well. For this reason, programs like Charge Ready are essential to the state's GHG emissions and air quality goals.

B.   SCE Conforming Portfolio – Action Plan

As explained previously, SCE requests Commission approval to move forward with procurement under the SCE Preferred Portfolio if two conditions are met. If those conditions are not met, SCE will procure in accordance with the SCE Conforming Portfolio. However, the SCE Conforming Portfolio does not include any resource additions through 2030; therefore, SCE does not make any request for procurement authority under the SCE Conforming Portfolio in this IRP.[151] To support the infrastructure needed to achieve California's 2030 GHG emissions goals, SCE's action plans related to transmission and reliability and transportation electrification for the SCE Preferred Portfolio are the same for the SCE Conforming Portfolio. Additionally, SCE requests that the Commission adopt its reliability threshold mechanism proposal (discussed in Sections I.C.4 and IV.C) regardless of whether the Commission selects the SCE Preferred or Conforming Portfolio.

1.   SCE Conforming Portfolio – Proposed Activities

The SCE Conforming Portfolio requires no procurement activities incremental to those that are already approved by the Commission. SCE's proposed activities related to transmission and reliability and transportation electrification for the SCE Preferred Portfolio are the same for the SCE Conforming Portfolio. SCE's proposed reliability threshold mechanism is also the same in either case.

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[151] As noted below, the SCE Conforming Portfolio assumes the current PCIA methodology remains in place and will change if the IOUs' GAM/PMM proposal is adopted to replace the PCIA.

2.   SCE Conforming Portfolio – Barrier Analysis

Uncertainty regarding the resolution of PCIA reform in R.17-06-026 remains a barrier to achieving appropriate procurement in line with the SCE Conforming Portfolio. As modeled, the SCE Conforming Portfolio requires no additional procurement, and as such there would be few barriers associated with SCE achieving this plan. However, the SCE Conforming Portfolio analysis assumes the current PCIA methodology remains in place. If the Commission approves the IOUs' GAM/PMM proposal in R.17-06-026, there would be resource additions in the SCE Conforming Portfolio (approximately 1.6 GW by 2030), and SCE would need to make adjustments to its future procurement plans. The Commission should take swift action on PCIA reform in order to provide regulatory certainty to all market participants and move California's decarbonization goals forward.

3.   SCE Conforming Portfolio – Proposed Commission Direction

Because SCE has no procurement need at this time under the SCE Conforming Portfolio, SCE makes no request for Commission direction on procurement related to that portfolio.

Regardless of the portfolio accepted by the Commission in this IRP, however, SCE's requests for Commission direction related to transmission and reliability and transportation electrification are the same. In particular, SCE requests that the Commission: (1) forward the SCE Pathway System Plan to CAISO to study as a policy-driven case in the CAISO's 2019-2020 TPP, and (2) ask the CAISO to study natural gas plant retirements, natural gas system constraints, and the effects of such retirements and constraints on reliability under both the Commission's Preferred System Plan and the SCE Pathway System Plan in the 2019-2020 TPP. SCE also requests that the Commission adopt an economy-wide, cross-sector approach when evaluating electric sector GHG emissions planning targets in the IRP process and continue taking other actions to support transportation electrification. Finally, the Commission should approve SCE's reliability threshold mechanism proposal as discussed in the next section.

C.   **The Commission Should Approve a Reliability Threshold Mechanism for Expedited**
        Procurement and Deployment of Flexible Energy Storage Resources to Address
        Potential System or Local Reliability Issues

To date, the IRP process has not fully considered the flexible resource availability needed
to ensure system and local reliability. As discussed above, despite acknowledging it as a
simplifying assumption that may not reflect reality, the Commission assumed all natural gas
plants (other than OTC units scheduled for retirement) will remain in operation during the
planning horizon. SCE made the same assumption in its IRP modeling. The IRP process has
also not considered natural gas system constraints or the potential default or delay of local
capacity resources contracted in past solicitations. SCE recommends that these issues be
thoroughly evaluated, in close cooperation with the CAISO, in future IRP cycles, including
through the TPP studies recommended above.

However, there will not be a Commission decision on the next cycle of IRP submittals
until at least late 2020. Until the Commission has fully assessed these risks, SCE recommends
that the Commission adopt a reliability threshold mechanism for expedited procurement and
deployment of flexible energy storage resources to address reliability concerns that may arise in
the interim.

As described below, SCE proposes that the Commission adopt reliability thresholds if
specific events that limit the reliability of the system occur, including significant unplanned near-
term retirements of natural gas plants; local capacity resources procured in past solicitations not
meeting their expected online dates, resulting in a local area shortfall; the CAISO declaring a
Stage 2 Emergency; or certain reductions in natural gas storage capacity or natural gas pipeline
constraints. If any of these reliability thresholds are reached, the Energy Division, in conjunction
with the CAISO, would conduct an expedited impact assessment to determine whether the event
created reliability concerns regarding the flexibility of the system or the ability to meet peak
demand. If the event does create a reliability issue, the Commission could then order accelerated

procurement of energy storage to address the reliability concern. Energy storage is the right option for rapidly responding to flexibility concerns on the system because it is a flexible resource that can be deployed quickly at scale.

A reliability threshold mechanism to rapidly deploy flexible energy storage resources is prudent because the reliability of the system is currently in a delicate balance with the impending retirement of the OTC units and the potential retirement of non-OTC units for economic reasons. In addition, the recent challenges to SoCalGas system deliverability due to the de-rating of the Aliso Canyon natural gas storage facility and other recent unplanned pipeline outages have heightened SCE's concerns regarding the ability of the natural gas system to deliver the needed natural gas for electric generation plants. In recent days (as of this filing), unprecedented (since the CAISO's Market Redesign and Technology Upgrade in 2009) day-ahead wholesale market prices have provided further evidence that the Southern California gas system and CAISO electric system have limited flexibility to affordably meet customer demand. This is an indicator that the system is likely approaching a reliability event condition.[152]

1. **Challenges Regarding the Availability of Flexible Resources May Create System or Local Reliability Concerns**

Flexibility in the electric grid is needed to integrate intermittent renewable resources and ensure system and local reliability. Energy storage can meet flexibility needs, and will need to be deployed at large scale by 2030 to help California meet its GHG emissions goals. Yet, until energy storage is deployed with sufficient capacity in optimal locations, the need for natural gas plants will remain to provide flexibility and maintain system and local reliability. But natural

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[152] Four of the five highest hourly day-ahead "SP15" (zonal indicator for Southern California) prices since the CAISO's Market Redesign and Technology Upgrade occurred on July 24, 2018, including the highest price observed at $964.75/MWh. Four of the ten highest daily average day-ahead prices in this zone occurred in the time period from July 19-24, 2018. July 24 was the most expensive day, with an average price of $283.90/MWh, which is more than twice the second highest price observed in recent history.

gas plant retirements, natural gas pipeline constraints, and reductions in natural gas storage capacity, could constrain the supply of flexible resources, potentially jeopardizing system and/or local reliability.

a) Natural Gas Plant Retirements

The CAISO's *2017-2018 Transmission Plan* suggests that while natural gas-fired generation retirements will continue throughout the system, there is little buffer to accommodate these retirements, causing the CAISO to invoke "back-stop" procurement constructs that require these resources to stay online.[153] The CAISO "identified potential system-wide reserve margin issues emerging with as little as 1000 to 2000 MW of retirements beyond the current planned retirements."[154] This buffer is already shrinking, with the announcement of the retirement of the 640 MW Etiwanda Generation Station.

The CAISO also emphasized the market pressure on the natural gas-fired generation fleet and the market constructs employed to address these pressures, citing "local capacity concerns that have led to the ISO entering in 2017 into the first new reliability must-run ('RMR') agreements for generation capacity since 2006, as well as to issue annual capacity procurement mechanism ('CPM') designations for two generating facilities for 2018."[155]

The CAISO's *2018 Summer Loads & Resources Assessment* also raises concerns of a potential shortfall of reserves occurring this summer as a result of climatic and market forces that could lead to a Stage 2 Emergency event.[156] The report states the CAISO:

> [F]aces significant risk of encountering operating conditions that could result in operating reserve shortfalls. The increased risk in 2018 over 2017 is primarily a result of lower hydro conditions and the retirement of 789 MW of dispatchable natural gas generation that had been available in prior summers to meet high load

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[153] *See* CAISO, *2017-2018 Transmission Plan*, March 22, 2018, available at: www.caiso.com/Documents/BoardApproved-2017-2018_Transmission_Plan.pdf.

[154] *Id.* at 22.

[155] *Id.*

[156] *See* CAISO, *2018 Summer Loads & Resources Assessment*, May 9, 2018, available at: http://www.caiso.com/Documents/2018SummerLoadsandResourcesAssessment.pdf.

conditions that persist after the solar generation ramps down in the late afternoon.[157]

CAISO modeling estimates slightly more than a 50% probability that the CAISO declares a Stage 2 Emergency for at least one hour this summer, an event which has not occurred since 2006 when the Commission instructed the IOUs to construct new system capacity to ensure a reliable electric grid.[158] A Stage 2 Emergency means that the CAISO has taken all mitigating actions and is no longer able to meet its energy requirements, requiring CAISO intervention in the market such as ordering power plants online.[159]

b)   Natural Gas Pipeline Outages

The *Aliso Canyon Risk Assessment Technical Report Summer 2018*, prepared by the Commission, CEC, CAISO, and LADWP, identifies regional natural gas infrastructure issues in Southern California that could affect electric system reliability this summer.[160] Available SoCalGas pipeline capacity is 16.6% lower than last summer, and if the 1-in-10-year peak gas demand cannot be met, it would result in gas curtailments to electric generators.[161] The report also concludes that the 1-in-10-year peak gas cannot be met if additional pipeline constraints are imposed.[162]

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[157] *Id.* at 10.
[158] *See id.* at 29; CAISO, *2018 Summer Loads & Resources Assessment*, Stakeholder Web Conference Presentation, May 17, 2018, at 3, available at: http://www.caiso.com/Documents/2018SummerLoads-ResourcesAssessment.pdf; CAISO, *Summary of Alert, Warning, Emergency, and Flex Alert Notices Issued from 1998 to Present*, available at: http://www.caiso.com/Documents/FlexAlertNoticesIssuedFrom1998-Present.pdf.
[159] *See* CAISO, *System Alerts, Warnings and Emergencies*, available at: http://www.caiso.com/Documents/SystemAlertsWarningsandEmergenciesFactSheet.pdf.
[160] *See* Commission, CEC, CAISO, and LADWP, *Aliso Canyon Risk Assessment Technical Report Summer 2018*, May 7, 2018, available at: www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/About_Us/Organization/Divisions/News_and_Outreach_Office/Aliso%20Canyon%20Summer%202018%20Technical%20Assessment.pdf.
[161] *See id.* at 3-4.
[162] *See id.*

c) Reductions in Natural Gas Storage Capacity

Both the ability to adequately refill and the ability to maintain appropriate supply at natural gas storage facilities for the winter months is also a concern. Either could lead to electric generation curtailment, as they have previously:

> Preliminary analysis of the 2017-18 winter events, including the two-week natural gas service curtailment to electric generators during the cold snap from February 19 through March 6, leads to two key observations. First, exceptionally warm temperatures kept demand lower than expected through mid-February. The much lower-than-expected demand resulted in little gas being pulled from storage.[163]

Having a system dependent upon warm weather is rather precarious:

> Last winter, the SoCalGas system avoided serious problems primarily because of unusually warm weather…. Without sufficient storage inventory in November, Southern California could see a repetition of last winter, with energy reliability hinging on the vagaries of the weather.[164]

SoCalGas is also concerned about its ability to refill natural gas storage inventory as it "expects current pipeline outages to extend through at least the peak [electric generation] summer demand period," and thus "SoCalGas will be challenged to fill storage inventory for the upcoming winter season."[165] Additionally, the ability to maintain storage inventory could be further compromised by a loss of gas storage capacity if operational constraints are imposed, as they are presently at the Aliso Canyon natural gas storage facility.

These three natural gas-related issues (plant retirements, pipeline constraints, and reductions in storage capacity) all provide leading indicators of a system with potentially limited flexibility. The risk to the system is increased if procured LCR resources do not meet expected

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[163] *Id.* at 13.
[164] *Id.* at 4.
[165] SoCalGas, *2018 Customer Forum*, May 9, 2018, at 25, available at: https://envoy.sempra.com/ebb/attachments/1525889393526_2018_Customer_Forum_Presentation.pdf.

operational dates due to project delays or terminations.[166] As such, additional flexible capacity with less dependency on the natural gas system may be needed in the near-term to address these local flexibility concerns.

2.   **Energy Storage is the Optimal Resource Capable of Quickly Providing Flexibility**

Energy storage is the optimal resource for rapidly responding to flexibility concerns on the system because it is a flexible resource that can be deployed quickly and at scale. To most effectively address these flexibility concerns, while also increasing the operational efficiency of the electric grid and managing impending renewable integration needs, System-Optimized Storage Resources should be preferred over market-only resources. As described previously, System-Optimized Storage Resources maximize customer and electric system benefits by achieving locational and operational synergies with the distribution and transmission system via coordination of siting and Commission oversight over operation. Because energy storage resources can act as both load and generation depending on their state of charge, they present unique challenges for system operators in that they can improve or degrade grid function depending upon where they are located and how they are operated. Accordingly, if energy storage is procured to address system or local reliability issues, it should be located and operated to maximize grid reliability, resiliency, and affordability.

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[166] For example, D.13-02-015 authorized SCE to procure capacity to meet LCR needs in the Western Los Angeles and Moorpark sub-areas. In D.16-05-050, the Commission approved, in part, the results of SCE's LCR RFO for the Moorpark sub-area, including the contract for the 262 MW Puente natural gas facility. However, on October 5, 2017, the CEC Siting Committee assigned to the Puente facility provided notice of its intent to issue a Presiding Member's proposed decision recommending denial of the Puente facility's certification. The CEC permitting process for the Puente project has since been suspended. On February 28, 2018, SCE launched the Moorpark LCR/Goleta Resiliency RFP to address the resulting LCR shortfall in the Moorpark sub-area.

3. Proposed Reliability Thresholds

For the time period before the resolution of the next IRP cycle (expected sometime in late 2020), SCE urges the Commission to approve reliability thresholds for expedited procurement and deployment of flexible energy storage resources to address potential system or local reliability issues should they arise. This reliability threshold mechanism would help to alleviate the need for potential emergency procurement of new flexible resources and/or the CAISO's need to designate RMR resources. Both scenarios could be unduly costly to customers and create inefficient market outcomes.

SCE's proposed reliability threshold mechanism would work as follows:

1. Reliability threshold reached: An event that limits the flexibility of the system occurs.

2. Impact assessment: Within 60 days of said event, the Energy Division would determine, with input from CAISO and other stakeholders, whether the event is sufficiently impactful to create reliability concerns.

3. Resolution: If Energy Division determines the flexibility of the system is adversely impacted and additional flexible resources are required to maintain system or local reliability, the Energy Division would propose a draft resolution for Commission consideration. The draft resolution would authorize one or more LSEs that are best positioned to manage the reliability concern to procure a specific amount of energy storage resources to meet the subject reliability need. After party comments on the draft resolution, the Commission would vote on the draft resolution.

4. Procurement: If the resolution is approved by the Commission, the designated LSE(s) would procure energy storage resources according to the resolution.

Each step is discussed in more detail below.

a) Reliability Threshold Reached

Table IV-19 includes a list of potential reliability threshold events that would prompt an impact assessment. These threshold events are intended to be cumulative. For example, one

unplanned retirement of a 300 MW natural gas plant would not prompt an impact assessment, but if there was then a second unplanned retirement of a 100 MW natural gas plant (for a total of 400 MW), an impact assessment would be needed because SCE has proposed a threshold level for unplanned retirements of gas-fired generation of 360 MW.

Table IV-19
Potential Reliability Thresholds

IRP Assumption Planning Assumption that May Overestimate System Flexibility	Reliability Threshold Condition that if Reached Results in Study of Flexibility Concern
IRP assumes no unplanned natural gas-fired generation retirements and that local capacity resources signed in past solicitations come online by expected online date.	• Additional unplanned natural gas-fired generation retirement(s) cumulatively exceeding 360 MW;[167] • IOU believes local capacity resources procured in past solicitations will not achieve expected online date, resulting in a local area shortfall;[168] and/or • CAISO declares a Stage 2 emergency.[169]

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[167] The CAISO's *2017-2018 Transmission Plan* cites concerns arising from as little as 1,000 MW of unplanned natural gas plant retirements. With the retirement of the 640 MW Etiwanda Generation Station on June 1, 2018, this leaves a flexibility buffer as small as 360 MW.

[168] In SCE's 2013 LCR RFO, approximately 1,880 MW of capacity was procured, of which more than 90% is flexible capacity (energy storage or natural gas-fired generation).

[169] Declaration of a Stage 2 Emergency suggests system operating conditions not seen in over a decade.

IRP Assumption Planning Assumption that May Overestimate System Flexibility	Reliability Threshold Condition that if Reached Results in Study of Flexibility Concern
IRP assumes natural gas storage facilities operate at current capacity and are able to refill to required seasonal levels.	• Event occurs causing Aliso Canyon capacity to drop below current allowed capacity (30.4 billion cubic feet ("BCF")) or other SoCalGas natural gas storage facility (Honor Rancho, Playa del Rey, La Goleta) has capacity reduced;[170] and/or • High demand results in inability to adequately refill natural gas storage facilities (including Aliso Canyon) for supply in subsequent summer/winter seasons.[171]
IRP assumes no natural gas pipeline constraints.	• Additional unplanned major pipeline outage/constraint.[172]

b) **Impact Assessment**

In this step, Energy Division would perform an impact assessment of the relevant reliability threshold event to determine whether the event has sufficiently affected system and/or local reliability to require the procurement of additional flexible energy storage resources. The impact assessment would include evaluating the appropriate solution to meet any reliability

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[170] SoCalGas stated that without the use of Aliso Canyon, it believes it could only support summer electric generation demand of 1.7 to 1.8 BCF per day. For comparison, summer 2018 electric generation demand is expected to be 1.97 BCF per day. *See* SoCalGas, *2018 Customer Forum*, May 9, 2018, at 25-26, available at: https://envoy.sempra.com/ebb/attachments/1525889393526_2018_Customer_Forum_Presentation.pdf

[171] With ongoing pipeline outages, SoCalGas will be challenged to fill storage inventory for the upcoming winter season and may have insufficient receipt capacity to both serve summer customer demand and refill storage facilities. *See id.* at 25.

[172] The *Aliso Canyon Risk Assessment Technical Report Summer 2018* states available SoCalGas pipeline capacity is 530 MMcfd lower than last summer (2,655 MMcfd in 2017 versus 3,185 MMcfd in 2018). For example, Line 2000 has been operating at reduced pressure and capacity is reduced by 30 MMcfd due to right-of-way ("ROW") expiration; Line 5000 may also be removed from service due to an expired ROW; and Line 4000 is operating at reduced pressure and could be removed from service. All outages are expected to continue into next year. *See* Commission, CEC, CAISO, and LADWP, *Aliso Canyon Risk Assessment Technical Report Summer 2018*, May 7, 2018, at 7, 18, available at: www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/About_Us/Organization/Divisions/News_and_Outreach_Office/Aliso%20Canyon%20Summer%202018%20Technical%20Assessment.pdf.

need, including consideration of whether the need is best met by procurement of flexible energy storage resources pursuant to the reliability threshold mechanism or other solutions, including transmission or energy storage being deployed as a transmission asset. The impact assessment would incorporate input from the CAISO, impacted LSEs, parties, and other relevant stakeholders (e.g., plant owners, pipeline owners, etc.), and be completed in 60 days. SCE believes that the 60-day period allows Energy Division adequate time to perform an impact assessment of appropriate scope, to determine whether the impact on the electric grid's reliability is sufficient to justify flexible energy storage procurement, while also addressing these issues with appropriate urgency.

c)   **Proposed Resolution**

If Energy Division's impact assessment concludes that system flexibility and/or total system capacity is adversely impacted such that additional flexible energy storage resources will be beneficial to maintain system and/or local reliability, Energy Division would issue a draft resolution directing the procurement of energy storage with an accompanying need determination. The draft resolution would also include allocation of the procurement to the relevant LSE or LSEs that Energy Division determines are best able to handle the reliability concern. Parties would then have the opportunity to comment on the draft resolution.

If the Commission approves the resolution and determines that new flexible energy storage resources are required to meet system or local reliability needs for the benefit of all customers in an IOU's service area, and the Commission determines that the IOU is best positioned to perform the needed procurement on behalf of all customers, the IOU would be permitted to allocate the net capacity costs of such procurement to all benefitting customers, including bundled service, CCA, and ESP customers, through the CAM.[173] CAM treatment is consistent with the cost allocation adopted in SCE's 2016 Aliso Canyon Energy Storage

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[173] *See* Cal. Pub. Util. Code §§ 365.1(c)(2); D.15-11-041.

("ACES") RFO.[174] If the Commission decides that a non-IOU LSE should procure new flexible energy storage resources to meet system or local reliability needs for the benefit of all customers in the LSE's service area, SCE does not object to the allocation of the net capacity costs of such procurement to all benefitting customers through a cost allocation mechanism similar to CAM, provided that the procurement meets the same criteria required for IOU CAM procurement (i.e., Commission approval of the contract, Independent Evaluator, review by stakeholders similar to the IOUs' CAM Groups, etc.).

d) **Procurement Process**

If the Commission approves a resolution directing LSEs to procure flexible energy storage resources to meet a system and/or local reliability need, the designated LSEs would conduct competitive solicitations to meet the need. Third-party contracts and utility-owned energy storage (if any) would be approved via a Tier 3 advice letter process. Tier 3 advice letters are the standard for procurement of preferred resources, including renewables, CHP, and DERs. The Commission has allowed contract approval via Tier 3 advice letter for previous energy storage procurement in the context of SCE's ACES RFO, and has approved other utility-owned energy storage resources, such as SDG&E's engineering, procurement, and construction projects, via advice letter.[175] Energy storage projects should not be subject to a lengthier approval process than is required for other preferred resources, particularly when they are being procured to meet a near-term system and/or local reliability need that has already been identified by the Commission.

e) **SCE's Procurement Resulting from Reliability Threshold Mechanism**

SCE expects that any procurement and deployment of flexible energy storage resources under the reliability threshold mechanism will occur within a short timeframe, and require these

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[174] *See* Resolution E-4791 at 5-6.
[175] *See* SCE Advice 3454-E, approved by Resolution E-4804; SDG&E Advice 2924-E, approved by Resolution E-4798.

assets to be deployed strategically at optimal locations. Looking at the system holistically, such that these assets maximize overall system value and reduce costs is thus imperative. As outlined previously, System-Optimized Storage Resources maximize customer and electric system benefits by achieving locational and operational synergies with the distribution and transmission system via coordination of siting and Commission oversight over their market operation. Utilities are well-placed to harness these benefits. As the owners and operators of the electric system, utilities are best positioned to identify the most optimal locations and highest value applications. Moreover, the energy provided by the energy storage systems must be delivered in a timely fashion with a high level of certainty: non-performance of energy storage systems could lead to significant reliability issues. In addition to locational and operational oversight, utility ownership of energy storage provides additional unique system and customer benefits, which are discussed below.

(1) Greater Deployment Optionality

Utility land ownership. Land ownership is a key benefit when a flexibility need arises with a short time to deployment. Utility land ownership at or near substations shortens the time needed to deploy resources from date of need determination because the land is already available. Because substation and right-of-way land is located throughout the utility's territory, it is expected to be located proximate to the identified need. Additionally, less work may be required to interconnect the resource due to the short distance to the substation. In the 2016 ACES RFO, available SCE land played a key role in enabling deployment in under three months.

Deployment Flexibility. Utilities also have greater flexibility to relocate, reconfigure, stagger deployment, and/or change technology given a short time to deploy, without having to negotiate costly contract amendments, when energy storage resources are utility-owned. For example, the utility could determine later in the project development process that energy storage could simultaneously meet an emergent reliability need, while also deferring the need for a new circuit if relocated to land at an adjacent substation. In this example, both the costs saved

by not deferring the circuit need and by not renegotiating the contract would accrue to customers. Moreover, given that storage resources would be procured to alleviate a short-term flexibility concern, the utility would have the flexibility to find other use cases for these resources in the future, and/or redeploy the energy storage facility to respond to a different emergent grid need.

(2)   Improved Reliability and Operations

Least-Cost Dispatch Operations. Utility bidding of required energy storage systems will also be consistent with least-cost dispatch, which facilitates desired customer outcomes of a cost-efficient energy system, enhanced grid reliability, and improves market function. Because there will be some flexible capacity resources, including natural gas and energy storage, not likely contracted as part of a RA plan, they will not have a must-offer obligation. Having a portion of the energy storage deployed onto the electric grid to meet this flexibility need keeps the market "in check" to ensure this flexibility need, and other grid services such as ancillary services, are being met at the least cost to customers. It also ensures that resources that are needed for reliable grid operations are offered to the market at their defined operating cost.

Prioritized Reliability Considerations. Utilities are responsible for ensuring a safe, reliable, and affordable electric system, and energy storage is an additional tool to fulfill that mission. Because utilities will always prioritize reliability over maximizing market revenues, the utility can operate an energy storage facility to respond to an emergent grid need, such as a major line outage. Conversely, a third party may not be able to contractually guarantee that their storage facility will not fail, or agree to drop the equivalent amount of load necessary to eliminate reliability impacts of an overload and resultant grid equipment failure. Moreover, ownership allows the utility to operate and maintain energy storage facilities based on physical limitations, rather than contractual and warranty limitations. For example, in the event of a grid emergency, the utility can prioritize reliability by operating the storage device safely, but beyond its warranted operating parameters, if deemed necessary. In such an event, a third

party should be expected to operate its facilities to maintain the ability to maximize revenues over the life of the facility.

(3)   Enhanced Value

Enhanced Use Case Optionality. Contractual limitations for how the energy storage facility will be operated need to be contained in a third-party contract for developers to finance the project. At some point in the future, the optimal operations or use case for the energy storage may change, requiring a contract amendment to effectuate the change. Renegotiating contractual limitations can be expensive and time-consuming, which may lead to a suboptimal use of the resource, whereas for utility-owned assets, no contractual limitations exist and the energy storage facility can be operated in any manner desired provided the utility can demonstrate its operations were prudent. Energy storage is still a comparatively new technology and thus the use cases that maximize customer benefit are likely unknown at this time, and could change over the life of the battery.

For example, in 2017 electric utility American Electric Power repurposed an energy storage facility originally installed in 2009 to provide backup power and defer a new substation in order to be able to participate in PJM's frequency regulation market. The benefits of this change accrued to American Electric Power's customers and because the facility was utility-owned, no costly contract amendments were required to update the battery's software to enable this change.[176]

Capture Full Value of Useful Life. When a third-party owns the energy storage facility, that party captures all residual value of the facility past its contracted life, whereas for utility-owned assets, such benefits accrue to customers. Because energy storage is still a relatively nascent technology, the asset life for different technologies and configurations is less certain and

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[176] *See* Peter Maloney, *Software upgrade to old sodium battery marks shift in AEP's storage strategy*, UtilityDive, May 9, 2017, available at: https://www.utilitydive.com/news/software-upgrade-to-old-sodium-battery-marks-shift-in-aeps-storage-strateg/442223/.

therefore difficult to contract around. Additionally, ownership allows the utility to decide what to do with the asset once it determines the end of its asset life is approaching: it can repair the asset, replace it, or decide to retire it. For example, an energy storage facility may have degraded to such a degree that it is no longer useful as a grid asset for transmission and distribution deferral or congestion relief, but the utility could still use the battery to obtain market revenues, such as black start or frequency regulation that may not require the battery to be used as frequently or require as much discharge capability. If the battery were owned by a third party, these benefits would be realized by the developer.

(4) Ownership Process

In light of these benefits of utility ownership, SCE believes the system will garner the most benefit if SCE is able to elect to own up to 50% of any energy storage procurement need allocated to SCE under the reliability threshold mechanism, subject to price competitiveness.[177] SCE would competitively source the energy storage equipment and installation services for any utility-owned energy storage and recommends the Commission employ a price competiveness benchmark similar to that used in SCE's 2016 ACES RFO.[178] Such a price competiveness benchmark should be based on previous applicable solicitations for energy storage resources that are then adjusted for contracting terms or solicitation circumstances that may have led to an increase or decrease in premiums. The price competiveness benchmark would be used to determine the cost competitiveness of the offers received, and establish if SCE should proceed with utility ownership.

SCE also recommends the Commission adopt some form of a centralized procurement framework for energy storage procurement resulting from the reliability threshold mechanism

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[177] If the Commission directs SCE to procure flexible energy storage resources under this mechanism, SCE requests authority to file a Tier 2 advice letter to establish a memorandum account to record any utility-owned storage costs.

[178] *See* Resolution E-4791 at Finding 51.

that is not readily able to be allocated to multiple LSEs. SCE is willing at this time, on an interim basis, to serve as a central procurement agent for reliability needs in its service area, under the reliability threshold mechanism, provided that a durable cost recovery and fair cost allocation framework (such as the existing CAM) is applied.

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V.

DATA

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SCE's New Resource Data Templates for the SCE Pathway System Plan, SCE Preferred Portfolio, and SCE Conforming Portfolio are included as Appendices D.1, D.2, and D.3, respectively. SCE's Baseline Resource Templates for the SCE Preferred and Conforming Portfolios are included as Appendices E.1 and E.2, respectively.

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VI.

LESSONS LEARNED

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A.   **Broader Vision**

SCE offers the following lessons learned as an opportunity to make the IRP process a more effective vehicle for facilitating California's decarbonized future.

First, the Commission should adopt an economy-wide, optimized view of how the state plans to explicitly meet its 2030 GHG emissions goal. The IRP's GHG emissions planning target and load assumptions must be grounded in a broader, statewide view of the role of the electric sector in enabling a cost-effective and feasible decarbonization path for the state.

To the extent SCE's Pathway approach is not adopted in the 2017-2018 IRP cycle, SCE urges the Commission to include cross-sector modeling and analysis in the next IRP to develop an economy-wide strategy for meeting California's 2030 GHG emissions target. This analysis must take into account the GHG abatement measures that need to take place in other sectors of the economy and the effects of such measures on the electric sector. The Commission should establish the 2030 GHG emissions planning target for the electric sector and assumptions

regarding electrification of other sectors based on this cross-sector modeling and analysis. The Commission acknowledged that more analysis is needed to set GHG emissions targets that encourage cross-sector GHG reduction opportunities, including electrification.[179] Based on its analysis, SCE strongly believes a more stringent 2030 electric sector GHG emissions planning target of 28-30 MMT and higher levels of electrification will be necessary to effectively facilitate achievement of the state's 2030 GHG emissions goal.

Second, the Commission should work with other state policymakers to improve inter- and intra-agency coordination to ensure the IRP process aligns with, and guides activities across agencies and across relevant resource proceedings at the Commission.

The IRP process relies upon significant inter-agency coordination. CARB's Scoping Plan targets are established based on CEC IEPR demand and DER forecasts, which also establish the baseline for CAISO transmission planning and IOU distribution planning processes. These demand and DER forecasts are, in part, predicated upon the impact of existing IOU-administered programs and tariffs designed and coordinated by the Commission, as well as building standards established by the CEC, among other state and local planning agencies. The Commission's IRP process also relies on the CEC's IEPR, the CAISO's TPP, and the CARB's GHG target setting.

Coordination among the Commission, CEC, CAISO, and CARB are an essential foundation of a successful IRP process. Energy Division staff's *Proposal for Implementing Integrated Resource Planning at the CPUC* recognized the importance of process alignment among state agencies. It stated: "Many resource planning activities are interdependent with those of the CPUC's sister agencies and the CAISO, so clearly defining these relationships is critical to ensuring both the efficacy of the IRP process, as well as consistency with the planning outcomes at the other agencies and the CAISO."[180] SCE agrees. The Commission should

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[179] *See* D.18-02-018 at 57-58, 146-147.
[180] *Proposal for Implementing Integrated Resource Planning at the CPUC, An Energy Division Staff Proposal*, May 17, 2017, at 76.

continue its external process alignment activities with the CEC, CAISO, and CARB, and stakeholder engagement on this issue may be helpful in the next IRP cycle. In particular, the timing and sequencing of activities among the agencies should be aligned to ensure that the latest information will be used in future IRP analyses. In this IRP cycle, updates to the Reference System Plan and LSEs' IRP assumptions were required after the Commission adopted the Reference System Plan to reflect the latest 2017 IEPR data. Better coordination of the timing of IEPR and IRP efforts may eliminate the need for constant updates.

With respect to intra-agency coordination among resource proceedings at the Commission, SB 350 provides that "[t]o eliminate redundancy and increase efficiency," the IRP process "shall incorporate, and not duplicate, any other planning processes of the Commission."[181] In the Order Instituting Rulemaking for this proceeding, the Commission identified IRP "as a sort of umbrella resource planning proceeding designed to be informed by, and also possibly influence, a number of resource-specific proceedings also underway at the Commission," including those related to the RPS, energy efficiency, BTM PV, and energy storage.[182] SCE agrees with this vision and believes additional work should be undertaken in the next IRP cycle to better define how IRP will inform other resource proceedings and reduce duplication.

The Commission should streamline interactions among existing resource proceedings so that the IRP can function as the Commission's central planning process. As part of its initial efforts, the Commission should link common data between proceedings to ensure consistent assumptions for common parameters such as costs, resource potential, and avoided costs. The Commission should also consolidate common activities such as planning and procurement across proceedings. Consolidating RPS planning activities into the IRP may be a good first step.

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[181] Cal. Pub. Util. Code § 454.52(d).
[182] *Order Instituting Rulemaking to Develop an Electricity Integrated Resource Planning Framework and to Coordinate and Refine Long-Term Procurement Planning Requirements*, R.16-02-007, February 11, 2016, at 3, 10-11.

While individual mandates and resource-specific programs remain in place for many resources, the state's GHG emissions goals will require procurement and other investments that go beyond individual mandates and programs. Using the IRP as the common platform to optimize the resources needed above and beyond resource and program-specific requirements will essentially supersede the planning requirement of these proceedings.

Third, in the next cycle, the IRP process must fully integrate and optimize both supply- and demand-side resources as part of a robust CRVM. The Commission's model for this IRP is primarily capable of optimizing supply-side resources, but the Commission recognized the need to include all demand-side resources as candidate resources in future IRPs.[183] SCE agrees that optimizing all resources is necessary if the IRP process is going to identify the best path to meet California's 2030 GHG emissions goal, and appreciates that Energy Division staff have begun efforts to more fully incorporate DERs into the IRP process in the Modeling Advisory Group.

Incorporating DERs into the IRP process as candidate resources results in a need to estimate the potential value of DERs in avoiding distribution costs. The Distribution Resource Plan proceeding has adopted analytical tools and process to identify grid needs and assess the potential avoided distribution cost value associated with deferring or avoiding distribution system upgrades. The IOUs have proposed an interim methodology for the 2019-2020 IRP cycle to use these tools to estimate the potential value of avoided distribution costs. If the modeling results for the 2019-2020 IRP demonstrate that avoided distribution costs materially affect the optimal amount of DERs, the IOUs plan to work toward developing a methodology that better accounts for locational aspects of avoided distribution costs.

It would also be prudent to explore a consistent cost-effectiveness framework across supply- and demand-side resources. The Integrated Distributed Energy Resource ("IDER") proceeding has begun to explore a cost-effectiveness framework for the deployment of DERs outside of traditional resource planning, implementation, and procurement proceedings. In some

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[183] *See* D.18-02-018 at 34, 51-52.

cases, the values identified in the IDER proceeding differ from those in the IRP proceeding. For example, the GHG adder for demand-side resources (straight-line price) differs from the more gradual GHG adder represented by the IRP planning prices. SCE believes in a consistent value for GHG abatement across both supply- and demand-side resources to achieve the least-cost GHG reduction options for customers. The IRP is the right venue to develop a common valuation methodology for all resource options and the CRVM provides a good opportunity to develop such methodology.

B. Additional Lessons Learned

1. Modeling Tools

SCE recommends several changes to the modeling tools the Commission uses, or directs LSEs to use, to conduct IRP analyses. First, the capacity expansion modeling tool used should be commercially available and capable of more advanced analyses than the current RESOLVE model. In addition, the Commission should make modifications to the CNS methodology and CNS Calculator. Finally, some key modeling inputs and assumptions should be updated to reflect current and anticipated market conditions.

a) Capacity Expansion Modeling Tool

A better capacity expansion modeling tool is required for future IRP cycles. SCE supports the Commission's efforts to evaluate and improve modeling capabilities for the next IRP cycle. As Energy Division staff develop evaluation criteria and examines potential tools, SCE requests the following specific recommendations be considered.

The capacity expansion model should be commercially available. A commercially available capacity expansion model should be used in developing resource portfolios for future Reference System Plans. This model should be developed by, and sourced from an established software company with dedicated customer support. In SCE's experience, the lack of commercial availability and accompanying dedicated support made the RESOLVE model more

challenging to use, and hampered the validation of the produced results thereby reducing confidence in the model's outcomes.

The capacity expansion model should include regional granularity. Any capacity expansion model the Commission selects for future IRP use should be capable of modeling emissions constraints not only at the system level, but also at the individual LSE level. Using a model with this feature will help LSEs to build their respective plans, and optimized to their specific load and load shape rather than simply taking a pro rata share of the Commission's Reference System Plan.

The capacity expansion model should be capable of modeling individual generator attributes and analyzing full year hourly data. In assessing the costs of generating units, the next capacity expansion model should represent each generator separately and include a measure of fixed operating costs. Aggregating units into one "super unit," as RESOLVE does, oversimplifies the system in a way that systematically miscounts emissions. For example, when all combined cycle gas plants are aggregated into one large unit, the minimum generation of the super unit (i.e., Pmin) is the average minimum generation of all the constituents. This obscures levels of hourly Pmin emissions – which need to be allocated to LSEs during hours with over-generation.

Further, including more granular data around power plant fixed operating costs will support the Commission and stakeholders in developing a more accurate view of the economic threshold for when a power plant may shut down or refurbish. Finally, the capacity expansion model should be designed to process the load, renewable supply shape, and hydro data for each of the 8,760 hours within a year. RESOLVE's simplified 37 days are inadequate to assess peak day events because there is not enough variability to stress the simulated power system at the predicted extremes.

The capacity expansion model should remain separate in scope from the production cost simulation tool. The capacity expansion model develops the long-term resource portfolio that satisfies emissions and other constraints. Since generator and transmission modeling

assumptions are simplified in capacity expansion models, detailed operational reliability and feasibility studies of proposed resource plans should be performed in production cost simulations where the generators are modeled in detail. The limitation of 37 types of days, discussed above, further supports the need for separation of the modeling scope. Even with the more advanced, "typical week" sampling method used by the ABB CE model, SCE determined that detailed modeling of each hour in production cost simulations through the 2030 planning year was necessary for assessing operational feasibility of the identified resource portfolios.

b) <u>Assumptions</u>

SCE recognizes that there are some key assumptions included in capacity expansion modeling to which the model is sensitive, and that these assumptions have either not been updated recently or may not reflect market operations. SCE is concerned that continued use of these assumptions may lead to modeling outcomes that are not reliable. This would include assumptions such as the unspecified import emissions intensity factor, future natural gas prices, cost and energy profiles of existing renewable contracts, and the availability of candidate renewable resources in specified resource areas.

SCE recommends the assumed emissions intensity for unspecified imports be updated, in cooperation with CARB. The unspecified import emissions intensity factor of 0.428 MT per MWh that the Commission uses in its modeling is consistent with CARB's Mandatory Reporting Requirement.[184] This figure has remained constant since 2010.[185] At the time, the emissions factor was assumed to be representative of a reasonable clean natural gas facility operating on the margin. However, given substantial changes in the generation mix

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[184] *See RESOLVE Documentation: CPUC 2017 IRP, Inputs & Assumptions*, September 2017, at 67.
[185] *See* 17 C.C.R § 95111(b)(1).

across the western grid,[186] and a general trend of improving natural gas plant heat rates,[187] SCE recommends that this assumption be reevaluated.

The IRP modeling outcomes are sensitive to this figure, in particular when considering how much in-state generation is required to achieve GHG emissions targets. The *RESOLVE Documentation: CPUC 2017 IRP, Inputs & Assumptions* notes that in-state natural gas plants are assumed to have a slightly lower emissions factor than that of unspecified imports.[188] This assumption will systematically lead the model to select in-state generation rather than imports to achieve GHG emissions goals. Commission analysis shows that one outcome of the Reference System Plan is that in-state gas units are assumed to run more, rather than accepting "dirtier" imports from out-of-state. This leads to modeled increased emissions from in-state units.

To the extent this assumption reflects reality, the Commission and parties will need to weigh this outcome against GHG and air emissions reduction goals, particularly in DACs. If this assumption does not accurately reflect in-state gas unit emissions factors relative to out-of-state imports, the model will overestimate how much in-state natural gas generation is required to concurrently serve load and achieve 2030 GHG emissions goals. For a robust analysis on how a system-wide emissions target or individual LSE plans impact DACs, emissions factors must be as accurate as possible and the analysis must consider potential systemic biases. SCE strongly recommends the Commission assess whether the current unspecified imports emissions factor is

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[186] Between 2011 and 2017, net natural gas capacity in the overall WECC system increased a total of approximately 11,000 MW, according to WECC State of the Interconnection reports. *See* WECC, *2011 State of the* I*nterconnection*, September 2012, at 24, available at: https://www.wecc.biz/Reliability/2011_WECC_SOTI_Report.pdf; WECC, *2017 State of the Interconnection, Resource Portfolio*, available at: https://www.wecc.biz/epubs/StateOfTheInterconnection/Pages/Resource-Portfolio.aspx.

[187] *See* Energy Information Administration, *Table 8.1. Average Operating Heat Rate for Selected Energy Sources, 2006-2016*, available at: https://www.eia.gov/electricity/annual/html/epa_08_01.html.

[188] *See RESOLVE Documentation: CPUC 2017 IRP, Inputs & Assumptions*, September 2017, at 79.

an appropriate reflection of emissions attributable to imported electricity or if changing market dynamics in the broader Western grid merit an update to this figure.

The transmission availability assumption should be modified to provide an accurate resource selection tool for LSEs in developing their IRPs. The Commission used the transmission availability provided by CAISO and the RPS Calculator to develop its parameters around technical resource constraints in IRP modeling. SCE elected to maintain consistency with the Commission in using these assumptions for its own modeling. However, SCE notes that additional refinement would be beneficial to the overall IRP modeling process.

First, its use in capacity expansion modeling does not allow the modeling tool to restrict resource selection by multiple LSEs in a given area. This can result in multiple LSEs selecting the same resource for their individual portfolios, which would cause the aggregated Preferred System Plan to over-select the resource from that particular region, in excess of its technical potential.[189] Second, SCE is concerned that the transmission availability assumption in RESOLVE may understate the amount of transmission upgrades that would be required to build a given set of renewable resources.

When SCE conducted its capacity expansion modeling, the results showed no new transmission upgrades were required; however, when evaluating the modeled portfolio in a more thorough transmission analysis, it appeared the optimized portfolio would have required new transmission. New transmission upgrades would raise the cost of the portfolio, such that it may no longer be cost optimal compared to another combination of resources. To avoid this time consuming manual iteration between the capacity expansion modeling to select a portfolio and a transmission system impact analysis to validate if transmission upgrades are required to support the selected portfolio, the transmission availability parameters used in RESOLVE or an

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[189] For example, if a given area has 100 MW of new wind potential, there is no way of knowing if more than one LSE chooses the same 100 MW to serve their load.

individual LSE's modeling should be refined. The new report should be designed specifically for use in IRP so that it appropriately evaluates resource availability in the current system.

SCE makes several specific recommendations regarding what should be included in the update:

- RESOLVE transmission zones should break down the overall MW into subareas. If capacity could be strategically placed, within a transmission zone, downstream of known transmission constraints and near generation retirements, existing system capacity could be better utilized and the requirements for new transmission upgrades would be minimized.

- It is unclear if the transmission availability provided by CAISO[190] for firm and EO resources are additive, which may contradict the RESOLVE model assumptions. The CAISO transmission availability inputs and RESOLVE modeling assumptions should be aligned to use similar assumptions for FCDS and EO resources. This alignment would avoid stakeholder confusion and help ensure that new transmission upgrades are not over or under estimated. Additionally, having combined FCDS and EO resource capacity numbers for each transmission zone would be worthwhile and realistic to study, since historical resource interconnections have consisted of both types of interconnections requests.

RESOLVE modeling is sensitive to financial assumptions parameters. SCE is concerned that some assumptions related to renewable and energy storage prices in RESOLVE's pro forma financial modeling are difficult to substantiate and may not reflect market conditions. For example, discounted cash flows currently account for the cost of equity as a discount rate rather than the weighted average cost of capital. This is not consistent with standard financial practices, and unless specifically substantiated, should be modified in future IRP cycles.

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[190] *See RESOLVE Documentation: CPUC 2017 IRP, Inputs & Assumptions*, September 2017, at 39.

The current analysis produces high cost of equity measures, which may unrealistically devalue the future costs of RESOLVE's candidate resources.

Further, discount rates and debt structures vary significantly from resource to resource, which may systematically bias one resource over others. It may be more prudent to group resources or assume uniform financial parameters for all resources. This will reduce the potential for assumptions to drive substantial swings in modeling outcomes. SCE has conducted sensitivity analyses which showed that minor changes to these assumptions can change the portfolio dramatically. For instance, when adjusting discount rates and equity shares, the portfolio returned increased or decreased geothermal capacity by over 100% relative to the Reference System Plan.[191] Rationalizing these financial assumptions will be critical to ensuring that California selects the least-cost portfolio, rather than allowing modeling assumptions to dictate outcomes.

c)   CNS Methodology and Calculator

SCE commends the Commission for adopting a load-based, hourly GHG accounting method for use in evaluating LSE portfolios. This is an important and substantial first step in understanding GHG emissions attributable to LSE load and proposed portfolios. Unlike other planning and compliance mechanisms, the CNS methodology helps stakeholders understand how load shapes and resources procured affect emissions on an hourly basis, and provides the information they need to plan future portfolios with an eye toward mitigating those hourly emissions.

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[191] SCE conducted sensitivity analyses that set all equity shares to 20% (rather than the Reference System Plan's range of 20-54%). SCE also adjusted discount rates to use the weighted average cost of capital of 8.3%, rather than varying discount rates from 12-25% depending on the resource.

As acknowledged in the Administrative Law Judge's ruling adopting the CNS methodology,[192] there are several modifications to the methodology that can be considered in future IRP cycles. SCE agrees with the following suggestions, and requests the Commission prioritize them for consideration in the 2019-2020 cycle.

Adding air pollutants such as NOx and PM 2.5 into the tool. SCE has developed an interim method to account for these emissions, both from steady state operations and starts and stops, and has used this approach to estimate emissions in this IRP. However, it is likely that not all LSEs will use this approach. Emissions reporting methodologies should be consistent so that the Commission can adequately compare and assess LSE portfolios. The Commission should undertake a public process to formally adopt air pollutant emissions estimates into the CNS Calculator, or a similar tool, for use in future IRP cycles.

Accounting for, and equitably allocating, emissions from generation operating at minimum load. The CNS Calculator does not account for emissions from natural gas plants that run at minimum levels (i.e., Pmin) throughout the day in order to be ready to meet ramping needs. For a full accounting of both GHG and air pollutant emissions attributable to load, it is important these emissions are included in the tool and spread across all portfolios proportionally to load. Over-generation should never be used to offset these emissions in the accounting tool, as they will occur regardless of how much renewable power is generated and placed on the grid at any given time.

Reevaluate or eliminate the method by which LSEs are credited for oversupply.

In the Administrative Law Judge's Ruling adopting the CNS methodology, the Commission changed the originally proposed methodology to "give LSEs credit for excess GHG-free energy provided to the grid in excess of its load, in hours in which the GHG-free

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[192] *See Administrative Law Judge's Ruling Finalizing Greenhouse Gas Emissions Accounting Methods, Load Forecasts, and Greenhouse Gas Benchmarks for Individual Integrated Resource Plan Filings*, R.16-02-007, May 25, 2018, at 17-18.

energy displaces energy from GHG-emitting resources."[193] However, SCE observes that there

are instances in which these credits may over-allocate GHG credits associated with an individual

LSE's portfolio, as observed when all portfolios are aggregated into the Preferred System Plan.

For example, there are some modeled hours (i.e., with low but non-zero emissions factors) in

which no one entity can know with certainty that its portfolio would displace emitting system

power or GHG-free energy. In these hours the sum of emissions for each individual LSE's plan

could be lower than the CNS Calculator would indicate if the portfolios are aggregated first, and

then emissions are measured for the full system portfolio.

Further, when the Commission begins to address Pmin-related emissions in a future

iteration of the CNS Calculator, it would be incorrect to allow an LSE to claim oversupply credit

to displace these emissions. This is because adding more GHG-free energy to the system would

not allow such generating units to avoid minimum generation needs. When considering the SCE

Conforming Portfolio, SCE used the CNS Calculator as provided by the Commission, but ran an

additional analysis to determine the effect of including Pmin. This is included in Table VI-20

below.

Table VI-20
SCE Conforming Portfolio GHG Analysis Including Pmin

				GHG emissions (MMT)			
Case	Analysis performed	Pmin emissions	Oversupply Credit	2018	2022	2026	2030
A	Commission's Methodology (as is)	Not included	Included	13.8	7.6	7.2	7.5
B	SCE's Methodology, without oversupply credits	Included	Not Included	14.1	7.9	8.0	7.8
C	SCE's Methodology, with oversupply credits	Included	Included	14.0	6.3	5.9	5.0

Including Pmin emissions, without adjusting how oversupply credits are calculated, will

systematically undercount portfolio emissions in the current tool. When including Pmin

emissions in the analysis (as in Cases B and C above), the system emissions level underlying the

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[193] *Id.* at 11-12

analysis never falls to zero, given Pmin represents minimum baseload generation that additional renewables cannot displace. In Case B, oversupply credits are not included, and thus emissions increase slightly over Case A, which is the expected outcome when including Pmin emissions. However, when including oversupply credits as well as Pmin, the tool will allocate substantial oversupply credits, as if additional renewable generation is, in fact, displacing system power. Case C exhibits 2.5 MMT of GHG emissions fewer than Case A where Pmin was not included at all. This outcome does not reflect realistic grid operations. Therefore, when the Commission includes Pmin in future iterations of the CNS Calculator and methodology, it should reexamine how oversupply is included in the tool to avoid this error.

2. Process Improvements

SCE has observed some challenges in the IRP process, and makes the following recommendations to address these issues in the next IRP cycle.

The Commission should establish a clearer process by which LSEs request load forecast modifications. California's electricity markets continue to undergo substantial change with the expansion of CCAs and load departure from IOUs. As such, it was necessary for the Commission to allow load forecast adjustments within the IRP cycle. However, D.18-02-018 provided sparse guidance on how LSEs should request load forecast adjustments and what information should be included in those forecasts so that the LSE from which load departs can conduct adequate bundled portfolio modeling. The Commission stated that "any entity seeking to establish or modify a GHG Benchmark previously assigned by the Commission may make a motion in the open IRP proceeding providing its rationale and justification."[194] But the Commission did not define what constitutes adequate "rationale and justification."

This gap has caused significant challenges for IOUs with departing load. For example, the Commission initially did not set a deadline for submitting new load forecasts. Although a

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[194] D.18-02-018 at 126-127.

148

deadline was eventually established,[195] by the time the last load forecasts were officially adopted, IOUs had fewer than 45 calendar days to incorporate changes into their IRP modeling and filings.[196]

Further, CCAs have provided varying levels of detail to justify why these load forecast requests are appropriate. Some filed motions that listed specific expansion plans, noting which geographic areas were being added to their service. Some simply noted that an expansion would be taking place. While SCE appreciates that the Commission has provided opportunities to respond to these requests, an IOU or other intervenor cannot evaluate the accuracy of these load forecasts without more information. Therefore, SCE suggests that the Commission work with the CEC to establish a robust process for adopting LSE departing load forecast changes for IRP purposes. This effort may require more coordination among IRP, RA, and IEPR proceedings to ensure reasonable levels of departing load forecast changes are modeled for IRP purposes.

Finally, it is important to note that departing load exhibit varying load shapes that do not always align with SCE's typical historical service area-wide shape. If the CCA serving departing load is located in a specific climate zone or serves a disproportionate share of one customer class, this will alter the shape SCE should use to model its own bundled portfolio and thus the optimal portfolio and resource mix. It is often not adequate to simply assume that departing load will have a shape similar to the rest of the service area.

To address these challenges, SCE recommends the Commission take the following actions for the 2019-2020 IRP cycle:

- **Define a standard time in advance of the IRP filing deadline for any given cycle by which load forecast adjustments will be due for inclusion in the current cycle**.

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[195] *See Administrative Law Judge's Ruling Finalizing Greenhouse Gas Emissions Accounting Methods, Load Forecasts, and Greenhouse Gas Benchmarks for Individual Integrated Resource Plan Filings*, R.16-02-007, May 25, 2018, at 21.

[196] *See Administrative Law Judge's Ruling Finalizing Load Forecasts and Greenhouse Gas Benchmarks for Individual Integrated Resource Plan Filings*, R.16-02-007, June 18, 2018.

The deadline should be set at least 120 days, but preferably longer, before the filing date. The cutoff date should also be defined well in advance of the IRP filing date, for clarity and transparency.

- **Coordinate with the CEC to define what constitutes adequate justification for load forecast adjustments and require LSEs to report these in order to have forecast adjustments approved**. As the CEC maintains the IEPR process, by which all LSEs are required to submit load forecasts biannually, it is likely the best positioned agency to facilitate load forecast adjustments, in cooperation with the Commission's IRP and RA staff. The agencies should work together to define a robust process for validating LSEs' proposed load forecast changes. At a minimum, this information should include definition of the geographic locations departing, expected customers per customer class, and expected load shapes. This will remove ambiguity and provide other intervenors adequate information by which to validate forecast adjustment requests.

Moreover, the Commission should require all LSEs to report assumed load shapes specific to their customers to the docket in the 2019-2020 cycle of IRP, for use in LSE modeling. Given a LSE's sensitivity to individual load shapes, and potential variability across large utility service areas, it is important that IOUs be able to adjust future forecasts for load that has already departed and for which load shapes had not been reported previously.

3. Electrification Considerations

In D.18-02-018, the Commission offered parties an opportunity to respond to questions regarding how increased electrification from transportation and building energy fuel switching may affect LSE load and GHG emissions target achievement.[197] SCE offers the following thoughts in response to the questions.

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[197] *See* D.18-02-015 at 146-147.

Estimation of expected load impacts from vehicle or building electrification.

SCE forecasts future transportation electrification load growth using its own internal model for LDV load, and has developed a view for non-LDV load based on external forecast. SCE considers both as positive load contributors. As a nascent and dynamic market, EV adoption is affected by multiple drivers such as manufacturer supply, policies set by federal, state, and local governments, and electric vehicle technology advancement.

Once vehicle population numbers are determined for each year, SCE calculates the total annual load by multiplying the number of forecasted EVs by the weighted average usage per vehicle (in kWh). Various factors are considered to determine hourly, daily, and annual electric vehicle charging load shapes. For all non-LDV transportation electrification forecasts, SCE bases its service area forecasts on the "in-between" statewide forecast case from ICF International and E3's *California Transportation Electrification Assessment, Phase 1: Final Report*.[198]

Figure VI-11 below compares the Preferred and Conforming (2017 CEC's IEPR Mid case) EV forecast scenarios in California.

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[198] *See* ICF International and E3, *California Transportation Electrification Assessment, Phase 1: Final Report*, August 2014, updated September 2014, at 15-16, available at: http://www.caletc.com/wp-content/uploads/2016/08/CalETC_TEA_Phase_1-FINAL_Updated_092014.pdf.

Figure VI-11
Comparison of California Light-Duty EV Forecasts

Comparison of Light-duty EV Forecasts Included in IRP Analysis
Vehicles, in thousands
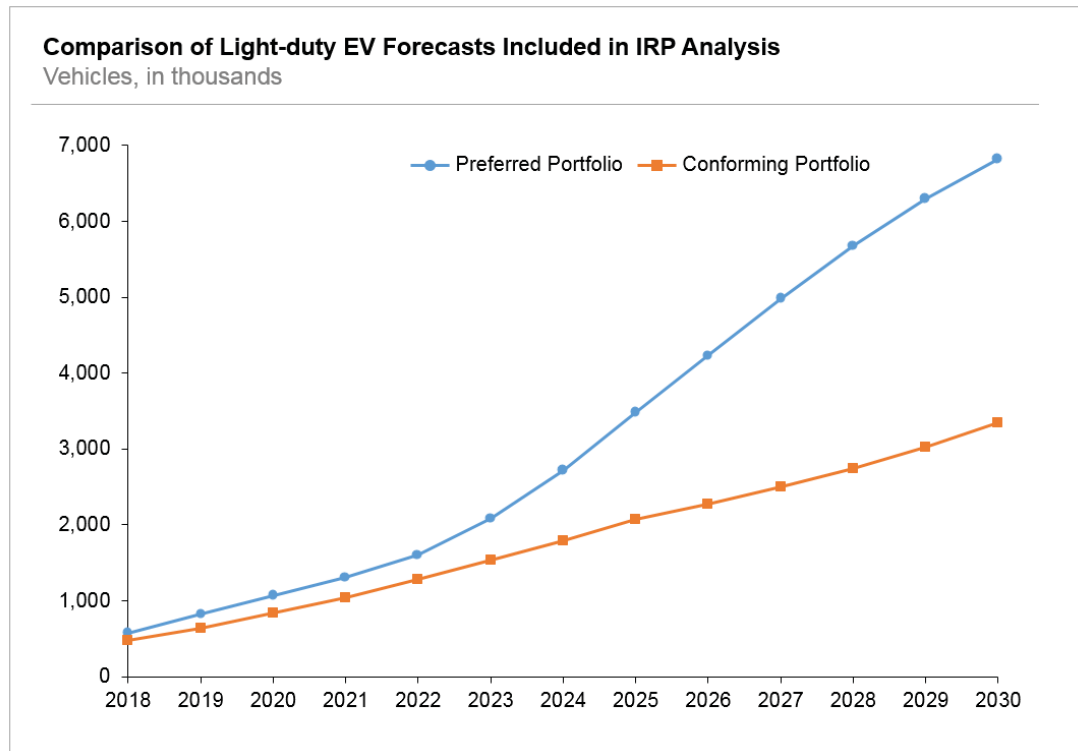
The types of infrastructure projects by LSEs that would produce the greatest GHG
benefits through electrification. Infrastructure projects by LSEs that help to reduce
electrification technology adoption barriers will produce the greatest GHG emissions benefits.
Examples include installation of away-from-home charging infrastructure, installation of multi-
unit dwelling charging infrastructure, programs that increase EV awareness, programs that
educate customers about building electrification technologies such as heat pumps for space and
water heating, and incentives to overcome the first-cost economic barriers to adoptions on
building electrification measures.

Accounting for the GHG benefits of electrification while potentially increasing the
GHG emissions in the electric sector. The electric sector has been at the forefront of the fight
against climate change in California. Although the electric sector accounts for only 16% of
California's GHG emissions, it has provided the majority of GHG emissions reductions in the

state since 1990.[199] Indeed, the electric sector has already reduced its GHG emissions by approximately 38% from 1990 levels,[200] and will further reduce GHG emissions as it meets a 50% RPS and customers continue to adopt DERs and these resources increasingly help to meet the electric grid's needs.

SCE believes that the electric sector must continue its leadership in reducing the threat of climate change and improving air quality. Sustained GHG emissions reductions in the electric sector will support California's clean energy future, while also helping to unlock decarbonization in other sectors. As such, SCE supports ambitious GHG emissions reduction goals for the electric sector; however, any GHG emissions reduction goals for the electric sector must be part of a holistic and systematic approach to reducing GHG emissions and air pollutants across sectors and throughout the state, particularly in the electric, transportation, and building sectors. This would reflect an integrated approach to planning with full consideration of the tradeoffs between all GHG emissions reduction measures, and will supplement existing GHG emissions reduction measures in all sectors of the state's economy.

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[199] *See* CARB, *California Greenhouse Gas Emissions Inventory for 2000-2016 – by Sector and Activity*, June 22, 2018, available at: https://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_sector_sum_2000-16.pdf; CARB, *Staff Report, California 1990 Greenhouse Gas Emissions Level and 2020 Emissions Limit*, November 16, 2007, at 6, available at: https://www.arb.ca.gov/cc/inventory/pubs/reports/staff_report_1990_level.pdf.

[200] *See id.*

VII.

CONCLUSION

For all the foregoing reasons, SCE respectfully requests that the Commission approve its IRP for the 2017-2018 cycle.

Respectfully submitted,

JANET S. COMBS
CATHY A. KARLSTAD

/s/ Cathy A. Karlstad

By: Cathy A. Karlstad

Attorneys for
SOUTHERN CALIFORNIA EDISON COMPANY

2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770
Telephone: (626) 302-1096
Facsimile: (626) 302-1910
E-mail: Cathy.Karlstad@sce.com

August 1, 2018

VERIFICATION

I am Vice President, Strategy, Integrated Planning and Performance, at Southern California Edison Company and am authorized to make this verification on its behalf. I have read the foregoing **INTEGRATED RESOURCE PLAN OF SOUTHERN CALIFORNIA EDISON COMPANY (U 338 E)**. I am informed and believe that the matters stated in the foregoing pleading are true.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this **30th day of July, 2018**, at Rosemead, California.

/s/ Steven D. Powell
By: Steven D. Powell
SOUTHERN CALIFORNIA EDISON COMPANY

2244 Walnut Grove Avenue
Post Office Box 800
Rosemead, California 91770

Appendix A

The Clean Power and Electrification Pathway

THE CLEAN POWER AND ELECTRIFICATION PATHWAY
Realizing California's Environmental Goals

November 2017
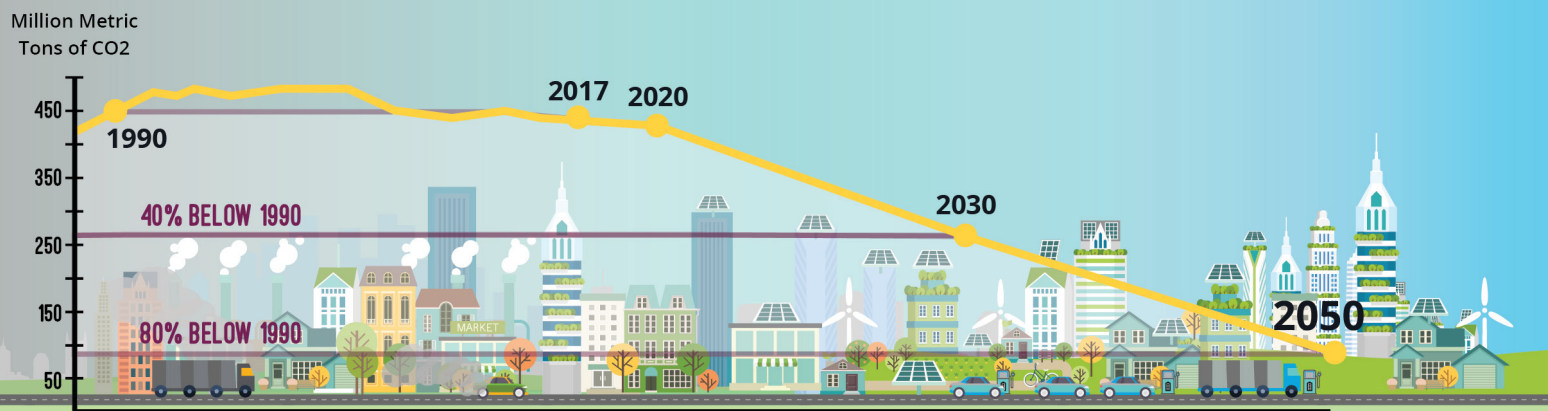
Figure 1: Meeting California's GHG Reduction Goals *(Source: California Air Resources Board [CARB])*

This paper presents Southern California Edison's integrated blueprint for California to reduce greenhouse gas emissions and air pollutants. Realizing the blueprint will reduce the threat of climate change and improve public health related to air quality. It is a systematic approach and each measure is integrated with — and depends upon — the success of the others. To be successful, California must approach implementation as an integrated package, applying resources across the board where most effective.

EXECUTIVE SUMMARY

Climate change and air pollution pose serious threats. Climate change effects, such as sea level rise and longer, more intense heat waves, are now occurring. In California, while significant progress has been made, too many communities continue to experience asthma and other air-quality-related health issues.

California continues its leadership in addressing climate change and air pollution. The state's greenhouse gas (GHG) goals call for a 40 percent reduction in GHG emissions from 1990 levels by 2030 and an 80 percent reduction by 2050 (Figure 1). Air quality goals include a 90 percent reduction in emissions of nitrogen oxides from 2010 levels in some of the state's most polluted areas by 2032. Meeting these ambitious clean energy and clean air goals requires fundamental changes over the next 12 years and beyond.

The electric sector is at the forefront of the fight against climate change in California and today accounts for only 19 percent of the state's GHG emissions. The transportation sector (including fuel refining) and fossil fuels used in space and water heating now produce almost three times as many GHG emissions as the electric sector and more than 80 percent of the air pollution in California.

The Clean Power and Electrification Pathway is an integrated approach to reduce GHG emissions and air pollution by taking action in three California economic sectors: electricity, transportation and buildings. It builds on existing state policies and uses a combination of measures to produce the most cost-effective and feasible path forward among the options studied.

The Pathway will help California achieve its climate goals and significantly reduce today's health-harming air pollution in local communities. It also has strong potential to create highly-skilled, middle-income jobs.

By 2030, it calls for:
- an electric grid supplied by 80 percent carbon-free energy;
- more than 7 million electric vehicles on California roads; and
- using electricity to power nearly one-third of space and water heaters, in increasingly energy-efficient buildings.

(Continued)

A - 1

(Continued - Executive Summary)

These electrified technologies will use zero-emission resources like solar and wind to provide most of their power, and can in turn support the electric grid by balancing electricity demand with supply.

The private and public sectors must work together to support customer adoption, while ensuring electricity remains reliable and affordable, and that end-use technologies are increasingly energy efficient. Public policy can enable the Clean Power and Electrification Pathway through comprehensive integrated resource planning that includes consideration of end uses of fossil fuels, through investing cap-and-trade revenues thoughtfully, and through supporting electrification in transportation, homes and businesses.

Southern California Edison is proud to be a long-standing partner with the state, customers and our communities on important climate change and air quality efforts. We look forward to continuing this broad-based partnership to pursue practical, cost-effective approaches to achieving a bold, clean energy future.
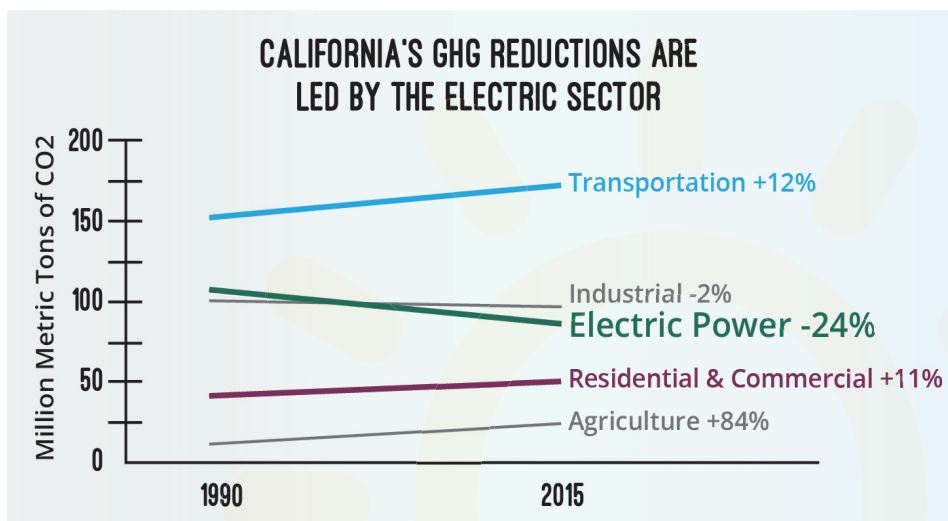
Figure 2: Change in California GHG Emissions *(Source: CARB)*

Successive California policies supporting GHG emissions reductions[1]
1. **SB 1078 (2002), SB 107 (2006), and SB X1-2 (2011)** established a Renewables Portfolio Standard (RPS), 20% by 2010 and then 33% by 2020.
2. **Executive Order S-3-05 (2005)** established a target of reducing GHG emissions 80% below 1990 levels by 2050.
3. **AB 32 (2006)** codified a GHG emissions target of 1990 levels by 2020 and created an economy-wide cap-and-trade program.
4. **SB 350 (2015)** established an RPS of 50% by 2030 and added new requirements for doubling energy efficiency and for wide scale transportation electrification deployment.
5. **SB 32 (2016)** codified a GHG target of reducing emissions 40% below 1990 levels by 2030.
6. **AB 398 (2017)** extended cap-and-trade program to 2030 and defined new offset levels.
7. **CARB Proposed Scoping Plan (2017)** identifies policies and tools to achieve the 2030 GHG target.

Additional major policy measures include the Low Carbon Fuel Standard, the Zero Emission Vehicle Program and Sustainable Community Planning.

2

INTRODUCTION

California is committed to reducing its greenhouse gas (GHG) emissions, improving local air quality and supporting continued economic growth. The state set goals to reduce GHG emissions by 40 percent from 1990 levels by 2030 and 80 percent from the same baseline by 2050 (Figure 1).[2] State and local air quality plans call for substantial improvements, such as reducing smog-causing nitrogen oxides (NOx) 90 percent below 2010 levels by 2032 in the most polluted areas of the state.[3] Meeting environmental goals of this magnitude will require fundamental changes to infrastructure and transportation and, at the same time, can help the California economy by creating jobs. These policy goals cannot be achieved by the electric sector alone.[4]

The Urgency of Meeting Climate Change and Air Quality Goals

Meeting California's pressing 2030 climate and air quality goals requires timely, proactive decision-making by policymakers and leaders throughout the state. Stakeholders must quickly align on the near-term programs and market transformation activities required to meet this ambitious

schedule. A systematic approach that integrates these programs and market activities provides the best chance of achieving shared goals at the lowest cost to customers and the economy.

The electric sector has provided the majority of emissions reductions in California (Figure 2) through energy efficiency, the phasing out of coal, and integration of new renewable resources. We are ahead of pace to reach a 50 percent renewables portfolio standard (RPS) by 2030.[5]

For California to meet its 2030 GHG target, significant emission reductions will be required from consumers of liquid and gas fuels — primarily in the transportation and building sectors. The transportation sector contributes nearly 40 percent of California's GHG emissions (approximately 45 percent when oil refining is included) and 80 percent of California's smog-forming NOx emissions.[6] The residential, commercial, and industrial sectors combined contribute approximately 30 percent of the state's GHG emissions (Figure 3). These emissions, as opposed to the emissions from the electric sector, have risen by more than 10 percent since 1990.[7]

A systematic approach that integrates these programs and market activities provides the best chance of achieving shared goals at the lowest cost to customers and the economy.
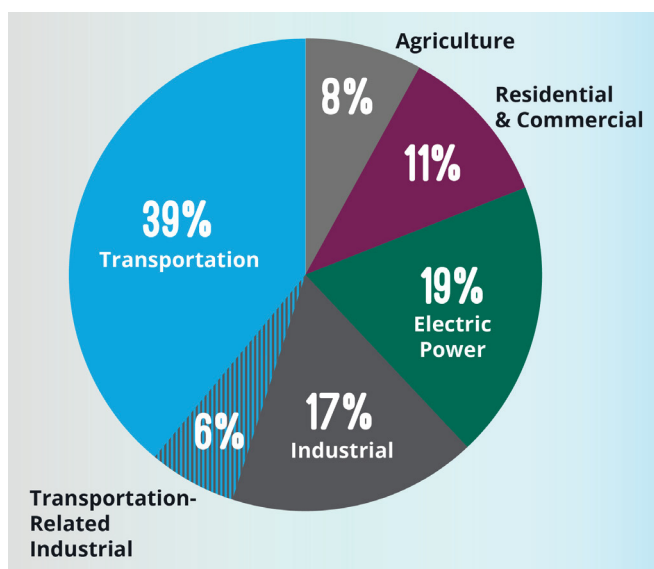
Figure 3: California GHG Emissions by Sector in 2015 *(Source: CARB)*

CLEAN POWER AND ELECTRIFICATION PATHWAY

California has taken concrete steps to move toward a clean energy future. Market-based policies such as the GHG cap-and-trade program and the low-carbon fuel standard provide a solid foundation by putting a price on carbon to encourage the most cost-effective actions to reduce or avoid GHGs. There are multiple pathways to meet California's 2030 climate goals, with varying levels of difficulty and costs. Some pathways are better than others in positioning the state to achieve 2050's deeper carbon reduction goals. SCE explored three alternatives (Table 1) and found that a clean power and electrification path is the most affordable and feasible approach to reaching California's climate and air quality goals. This pathway also will contribute to a strong state economy and can be an engine for creating highly-skilled, middle-income jobs.[8]

Table 1: Comparing 2030 Decarbonization Pathways *(Source: SCE Internal Analysis using E3 Pathways Model. Available at sce.com/pathwayto2030)*

PREFERRED PATHWAY

CLEAN POWER AND ELECTRIFICATION	RENEWABLE NATURAL GAS (RNG)	HYDROGEN (H2)
• **80%** carbon-free electricity supported by energy storage	• **60%** carbon-free electricity	• **80%** carbon-free electricity
• At least **24%** of light-duty vehicles are EVs (7MM)	• **24%** of light-duty vehicles are EVs (7MM)	• **22%** zero-emission light-duty vehicles (4MM H2, 2MM EV)
• **15%** of medium-duty and **6%** of heavy-duty vehicles are electrified	• **12%** of medium- and heavy-duty vehicles use compressed natural gas	• **4%** of heavy-duty vehicles use H2
• **Up to 30%** efficient electrification of commercial and residential space and water heating	• **42%** of natural gas replaced by RNG	• **7%** natural gas replaced by hydrogen
• Dependent on broad adoption of electrified technologies • Most feasible pathway because technology already exists	• Power-to-gas not yet commercially available • A large biogas market requires expensive imports	• Most expensive pathway • Requires significant H2 adoption outside of CA • Lack of sufficient delivery infrastructure
Incremental abatement cost (last 36 MMT)* **$79/ton**	**Incremental abatement cost (last 36 MMT)** **$137/ton**	**Incremental abatement cost (last 36 MMT)** **$262/ton**

*The pathways analyzed include measures to achieve the full 2030 GHG abatement (180 MMT), such as existing state policies and programs included in CARB's Proposed Scoping Plan and additional measures. 36 MMT represents the last 20 percent of GHG abatement needed to meet the 2030 target after offsets are used. This incremental abatement is incentivized by the cap-and-trade market.

THE VISION FOR CLEAN POWER AND ELECTRIFICATION

The Clean Power and Electrification Pathway is an integrated approach that builds on existing state programs and policies to achieve California's climate and air quality goals, while ensuring that an economy-wide transformation happens in an efficient and — importantly — affordable way. Using existing technologies, the Pathway calls for an electric grid with more carbon-free energy, which is used to clean other sectors of the economy. As the electric supply becomes cleaner, every electric vehicle and electric space or water heater becomes cleaner over its lifespan.

The Clean Power and Electrification Pathway...builds on existing state programs and policies to achieve California's climate and air quality goals...

The Clean Power and Electrification Pathway to 2030 is defined by three measures. Each measure is integrated with — and depends upon — the success of the other and should be pursued in concert:

1. **Continue carbon reduction in the electric sector:** increase energy efficiency, provide 80 percent carbon-free energy through large-scale resources and use distributed solar.

2. **Accelerate electrification of the transportation sector**, including placing at least 7 million light-duty passenger vehicles on the roads and supporting a transition to zero-emission trucks and transit.

3. **Increase electrification of buildings:** electrify nearly one-third of residential and commercial space and water heaters.

Continue Carbon Reduction in the Electric Sector

Electric sector measures, including providing 80 percent carbon-free energy from large-scale resources, and leveraging energy efficiency and distributed solar will lower GHG emissions from 84 to 28 million metric tons (MMT)/year (Figure 4). This represents 31 percent of the 2030 GHG reduction goal and aligns with California's pillars for carbon reduction and decades of state energy policy.[9]

Large-scale renewable energy is likely to be the most significant and affordable means of decarbonizing the electric supply. The transmission grid can provide 80 percent carbon-free energy from a combination of renewable resources including wind, solar and large hydroelectric

Figure 4: GHG Reductions Across Sectors to Reach 2030 Goals

generators. This will require the development of up to 30 gigawatts (GW) of additional renewable capacity.

California's electric system can incorporate a high penetration of large-scale renewable resources by having a renewables portfolio that is diverse in geography and resource availability, increasing transmission capacity, and enhancing integration across the western grid.

Using a system that relies so heavily on variable resources like wind and solar will require up to 10 additional GW of energy storage from fixed and mobile sources to even out hourly, daily and seasonal energy imbalances (the differences between energy supply and usage).

Even at today's levels of renewables, these energy imbalances can result in California's infamous "duck curve" — the timing imbalance that exists between solar generation and daily peak load.[10] This creates two significant problems for today's electric grid:
- the excess supply of solar at midday, which can lead to shutting down large-scale renewable resources or paying other states to take our power; and
- the significant fast ramp-up in generation to reliably cover the late afternoon and evening electricity need as the sun sets, solar generation fades and customer energy demands peak.

The extremes of the duck curve can be mitigated by the addition of energy storage at scale. Flexible electric vehicle charging could also provide beneficial load shifting — effectively a form of mobile energy storage — that could make electric fueling more affordable. Nonetheless, the magnitude of the duck curve issues is expected to increase as

more renewables are added to the system, and some amount of gas-fired generation will be needed for service reliability.

Reducing or avoiding carbon in the electric sector also requires advances to integrate the clean energy resources that customers are adopting. These resources on the distribution grid are expected to include increased energy efficiency (consistent with SB350's mandate to double energy efficiency), rooftop and community solar, and electric vehicles. Modernizing the distribution grid with available and evolving technologies will allow these distributed energy resources to be better integrated and optimized, will improve system reliability and safety, and will support our customers' desire to participate in the clean energy future by making their own energy choices.

Accelerate Electrification of the Transportation Sector
The GHG reduction potential of the Clean Power and Electrification Pathway hinges on aggressive electrification of light-duty vehicles, i.e., the passenger cars, SUVs and pickup trucks that currently contribute one-quarter of California's GHG emissions.[11] The Pathway calls for at least 24 percent of these vehicles — 7 million — to be electrified by 2030. EVs charging from an increasingly clean electric grid can help reduce transportation sector GHG emissions from 169 to 111 MMT/year, one-third of the 2030 goal. Reduced gasoline demand will also provide the benefit of reducing industrial emissions from refineries.

Electrification of the transportation sector will greatly improve local air quality — an urgent community need across California and particularly

Modernizing the distribution grid with available and evolving technologies will...support our customers' desire to participate in the clean energy future by making their own energy choices.

6

in Southern California. Many communities, particularly DACs*, are situated near heavily traveled freight corridors, where the concentration of air pollutants often exceeds health-based standards.[†]

Medium- and heavy-duty vehicles contribute to GHG emissions and are the largest mobile source of smog-forming emissions across the state. The Pathway calls for electrifying 15 percent of medium-duty and 6 percent of heavy-duty vehicles in the state by 2030, supporting needed GHG reductions and improvements in air quality. This will help California position itself for the 2050 GHG goal, which will require the elimination of virtually all vehicle emissions from fossil fuels.[12]

While these vehicle growth targets are ambitious, they are not far outside forecasts of rapid growth in the EV market.[13] Growing customer interest,

increasing availability and variety of EV models (Figure 5), and the favorable economics of using EVs for ridesharing and autonomous vehicles have made a high-EV future more plausible than ever. Nations such as the United Kingdom, France, Norway, India and China have announced plans to phase out internal combustion vehicles within coming decades. Manufacturers are responding; GM recently indicated that it expects the company's entire model lineup to run on electricity in the future, and Volvo committed to eliminating traditional internal combustion engines in favor of an electric and hybrid fleet as early as 2019.[14]

Expanding transportation electrification will require sustainable policies and collaboration between vehicle manufacturers, charging companies, policymakers and electric utilities on issues such as charging standards and consumer awareness.[15]
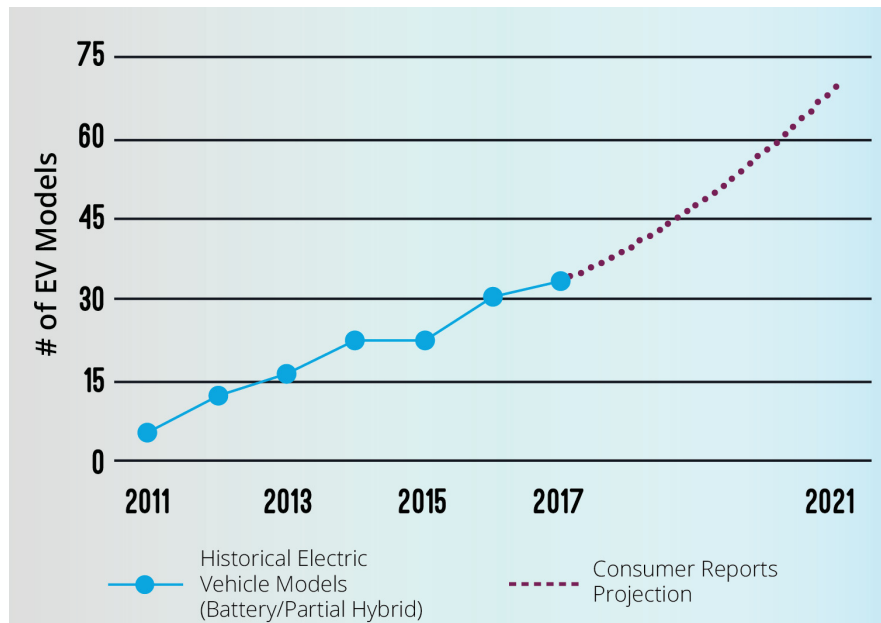
Figure 5: Battery/Partial Hybrid Electric Vehicle Models
(Sources: U.S. Department of Energy/Consumer Reports)

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*CalEPA uses the designation Disadvantaged Community (DAC); DACs represent the 25% highest scoring census tracts in CalEnviroScreen 3.0, along with other areas with high amounts of pollution and low-income populations.
[†]Electrification in areas such as the I-710 corridor between Long Beach and Los Angeles promotes environmental justice by insuring that climate investments provide near-term air quality benefits to a broad set of communities.

Continued price incentives, funded by the cap-and-trade and low carbon fuel standard programs, help to lower up-front purchase costs and will help drive additional adoption, as will increased selection and EV availability.

In order to support at least 7 million electric cars by 2030, California will need to have over one million away-from-home charging ports.[16] The state's investor-owned and public utilities have initiated charging infrastructure pilots*[17], but these pilots alone will not meet the expected scale of light-duty EV adoption. Funding will be needed to enable utilities and charging companies to rapidly deploy more infrastructure and chargers.

For medium- and heavy-duty vehicles in urban areas with lower daily mileage, such as buses, delivery vehicles and intermodal freight trucks, electrification is already being deployed and can significantly reduce GHG emissions and improve air quality. Larger plug-in electric and plug-in hybrid electric trucks are in development[18] and will play a greater role in achieving California's 2050 climate and air quality goals. Early deployments must coincide with the development of adequate charging infrastructure to support this critical clean-transportation opportunity.

Increase Electrification of Buildings
Space and water heating currently contributes more than two-thirds of total residential and commercial building GHG emissions. Electrifying nearly one-third of residential and commercial space and water heaters, in addition to increased energy efficiency and strong building codes and standards, could reduce GHG emissions from this sector from 49 to 37 MMT/year, or 7 percent of the 2030 goal.

Current codes and standards are based on the 20th century power-generation supply framework dominated by fossil fuels.

Expanding electrification of residential and commercial buildings will require new policies and support. Collaboration between manufacturers, repair service providers and policymakers is needed to raise awareness and increase availability of clean, efficient options for electric space and water heating in new building construction and retrofits. Current building codes and standards are based on the 20th-century framework of power generation supply dominated by fossil fuels. This framework should be updated to account for an increasingly decarbonized electric grid.

Updated codes and standards can advance the use of clean electric appliances in new buildings, and incentives can encourage adoption of clean technologies through appliance replacement. For instance, controllable electric space and water heating, which draws from carbon-free electricity powered by solar in the middle of the day, could be an evolution of the Zero Net Energy (ZNE) framework toward more carbon-focused principles for new home construction.[19]

REACHING OUR GOALS WITHIN 12 YEARS

While the Clean Energy and Electrification Pathway is feasible, meeting the 2030 climate goal and also achieving significant improvements in air quality is an urgent challenge, requiring focused efforts and purposeful actions across multiple sectors of the economy (Figure 6). Many of the needed approvals, programs, and market transformations require compromise and consensus among stakeholders with diverse agendas and priorities. Customer adoption is also key to success — and that adoption requires that electricity remains an affordable alternative to fossil fuels.

*For instance, SCE's Charge Ready program is a $22 million pilot to increase charging infrastructure throughout the SCE service territory. The program provides the electrical infrastructure necessary for EV charging, as well as rebates to help pay for charging stations.

SCE's Clean Power and Electrification Pathway calls for integrated actions, programs and policies across all sectors of the economy and strongly links grid decarbonization with electrification right from the start. Planning for 2030 reduction targets now provides a starting point for important, necessary policies, programs and actions needed to meet the even more transformational 2050 climate goals.

Putting millions of electric vehicles on California's roads requires overcoming current barriers, such as vehicle affordability, customer awareness and EV charging accessibility. Durable, predictable incentives that lower EV purchase prices will encourage buyers to choose plug-in models at the end of their gasoline-powered vehicles' 11-year life cycles. Healthier incentives will also be needed to encourage commercial enterprises to switch to electricity as a fuel for buses and delivery and intermodal trucks with 18-year average life spans. In addition, charging station networks will need to expand rapidly to ensure availability at workplaces, multifamily units and along heavily traveled corridors.

An electric system upgrade can take as long as a decade to site, license, build and commission. Planning often involves a consensus-driven process that rarely results in a quick decision.

Given this timeline, for the majority of electric power in California to come from renewable and distributed energy resources by 2030, the planning process for additional transmission capacity, new renewable energy development projects, grid modernization and large-scale energy storage investments must start now.

California's Building Energy Efficiency Standards are updated every three years, at the culmination of a multi-year planning process. Development of the 2019 standards is nearing completion, and planning for 2022 standards is an opportunity for strategic discussions. Waiting until the 2025 cycle could cost California the opportunity to decarbonize hundreds of thousands of new homes through electrified space and water heating, at a lower cost than later retrofits.

SUPPORTING THE PATHWAY THROUGH CALIFORNIA POLICY

Integrated Resource Planning
California has begun integrated resource planning — a comprehensive planning process to meet forecasted electricity needs and GHG targets for the electricity sector. Planning a decarbonized grid in a cost-effective manner requires strong coordination and balanced trade-offs for the good of the overall system. Provided that its scope includes consideration of
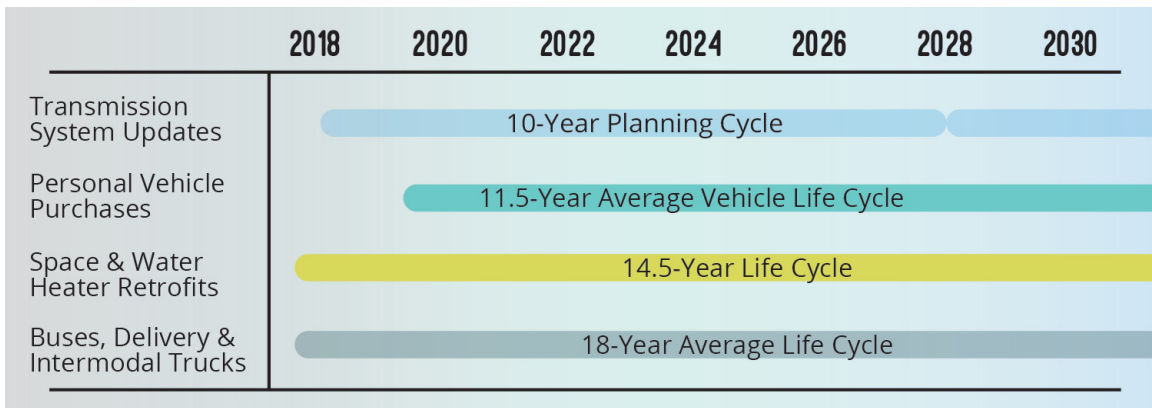
Figure 6: Planning and Life Cycle Timeline *(Source: SCE Internal Analysis)*

Planning a decarbonized grid in a cost-effective manner requires strong central coordination and balanced trade-offs across many parties for the good of the overall system.

the end uses of fossil fuels, this new process has the potential for more efficient planning decisions across economic sectors and electric sector technologies. This kind of planning would include large-scale and customer-sited renewable resources, energy efficiency, electric vehicles, energy storage and more.

GHG Cap-and-Trade
California's market-based, GHG cap-and-trade program is a critical enabler of the Clean Power and Electrification Pathway. Setting a price on GHG emissions with limited offsets creates opportunities to optimize spending in areas that most cost-effectively reduce or avoid GHG emissions. The continued, direct allocation of emissions allowances to utilities helps ensure electricity remains affordable and competitive with fossil fuels during the transition to the clean energy future.

Market-based programs could be bolstered by new flexible policy tools and significant funding to spur customer choice for clean electrification. California policymakers should allocate additional cap-and-trade revenues to programs that encourage consumers to adopt transportation and building electrification.

Transportation Electrification
New or refreshed policies could be enacted to smooth the pathway to broad customer adoption of electric vehicles. These policies could include support for continued and expanded consumer education, continued incentives for EV purchases, adequate charging infrastructure, and pricing that keeps electric fueling costs competitive with gasoline and diesel. Efforts are also needed to ensure the affordability of, and access to EVs for mid- and low-income Californians.

Building Electrification
California's 2022 Building Energy Efficiency Standards could include establishing new building standards to promote the clean electrification of space and water heating in homes and businesses, as well as to require collecting more data on fossil fuel end uses. In addition, energy efficiency programs could be optimized to include a focus on their ability to support GHG emissions reductions.

Keeping Clean Electricity Affordable
A key consideration for many consumers is, and will remain, the cost of electricity. The success of the Clean Power and Electrification Pathway rests on implementing an integrated package of measures that contribute to a strong California economy and maintain affordable electricity for all customers.

The price of electricity and who pays the costs must reflect the services provided to customers. All users of the electric grid must pay their share to support a reliable and increasingly clean electric system. Policies that ensure this fairness will help to keep electricity affordable, which will support customer adoption of the electrified solutions in the transportation and building sectors.

Creating Jobs That Support the Clean Energy Economy
A clean energy future benefits the California economy. Many studies suggest that the clean energy and electrification measures described in the Pathway will lead to higher statewide gross product, real output, state revenue and employment.[20] Highly skilled, middle-income jobs will be created to introduce and service new technologies. The Clean Power and Electrification Pathway can be a double win — both more prosperous and healthier — for California's residents.

10

CONCLUSION

Because of California's size and economic complexity, it will be a major undertaking for the state to meet its GHG goal in just 12 years. It is similarly difficult to meet our air quality targets. As the world's sixth largest economy, California has a unique opportunity to create a blueprint that others can follow for an affordable clean energy economy that improves air quality for our communities and mitigates impacts of climate change through greenhouse gas reductions across all energy sectors: electricity, fuels and gases.

Electric utilities are uniquely positioned to facilitate the transformation to a clean energy economy. They have the size, scope and infrastructure assets to deliver clean energy and support electrification for all customers. They also have the capacity to finance prudent investments to maintain and modernize the grid, with regulatory approval. But, they cannot do it alone. Broad decarbonization and electrification of the economy require comprehensive policy to guide the transformations across our economy — not just in the electric sector.

Everyone who lives, works, drives or invests in California is a stakeholder in this effort. The results will be a new energy paradigm that will address the enormous challenge of global climate change through the reduction of GHG emissions, improved air quality and human health — providing access to clean energy for all consumers.

Broad decarbonization and electrification of the economy requires comprehensive policy to guide the transformations across our economy — not just in the electric sector.

DECARBONIZE THE ELECTRIC SECTOR

ELECTRIFY THE TRANSPORTATION SECTOR
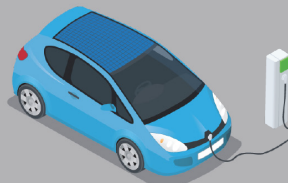
ELECTRIFY BUILDINGS
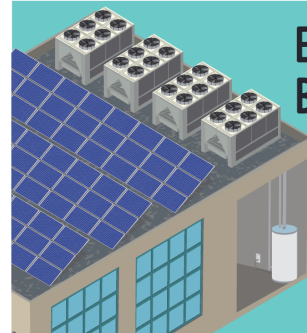
ACRONYMS

AB	Assembly bill (California State Assembly)	**HDV**	heavy-duty vehicle
		MDV	medium-duty vehicle
BEV	battery-powered electric vehicle	**MM**	million
CAISO	California Independent System Operator	**MMT**	million metric tons
		NOx	nitrogen oxide
CARB	California Air Resources Board	**PHEV**	plug-in hybrid electric vehicle
CNG	compressed natural gas	**RNG**	renewable natural gas
EV	electric vehicle	**RPS**	Renewables Portfolio Standard
GHG	greenhouse gas	**SB**	Senate bill (California State Senate)
GW	gigawatt	**SCE**	Southern California Edison
H2	hydrogen	**ZNE**	zero net energy

REFERENCES

SOUTHERN CALIFORNIA
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1. For more information on these policies, see Appendix at sce.com/pathwayto2030

2. Edmund G. Brown, Matt Rodriquez, Mary D. Nichols and Richard W. Corey, "First Update to the Climate Change Scoping Plan: Building on the Framework Pursuant to AB 32, The California Global Warming Solution of 2006," California Air Resources Board, last modified May, 2014, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf

3. "Vision for Clean Air: A Framework for Air Quality and Climate Planning - Public Review Draft June 27, 2012," p. 10, California Air Resources Board, last modified June 27, 2012, accessed Oct 12, 2017. https://www.arb.ca.gov/planning/vision/docs/vision_for_clean_air_public_review_draft.pdf

4. "California Greenhouse Gas Inventory for 2000-2015 - by Sector and Activity," California Air Resources Board, last modified June 6, 2017, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/inventory/data/tables/ghg_inventory_sector_sum_2000-15.pdf

5. "California Renewables Portfolio Standard (RPS): Current Renewable Procurement Status," California Public Utilities Commission, accessed Oct 6, 2017. http://www.cpuc.ca.gov/RPS_Homepage/

6. California Greenhouse Gas Inventory

- "Mobile Source Strategy," p. 5, California Air Resources Board, last modified May, 2016, accessed Sept 25, 2017. https://www.arb.ca.gov/planning/sip/2016sip/2016mobsrc.pdf

7. California Greenhouse Gas Inventory

8. For more information on job creation, see Appendix at sce.com/pathwayto2030

9. The Governor's Climate Change Pillars: 2030 Greenhouse Gas Reduction Goals, California Air Resources Board, last modified Sept 20, 2016, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/pillars/pillars.htm

10. "What the duck curve tells us about managing a green grid," California Independent System Operator, last modified 2016, accessed Sept 20, 2017. https://www.caiso.com/Documents/FlexibleResourcesHelpRenewables_FastFacts.pdf

11. California Greenhouse Gas Emission Inventory - 2017 Edition: Data Links - Download the Entire Inventory - Economic Sector Categorization [Excel-496 KB], California Air Resources Board, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/inventory/data/data.htm

12. James H. Williams, Benjamin Haley, Fredrich Kahrl, Jack Moore, Andrew D. Jones, Margaret S. Torn and Haewon McJeon, "US 2050 Report: pathways to deep decarbonization in the United States," Sustainable Development Solutions Network - A Global Institute for the United Nations, last modified Nov, 2014, accessed Sept 28, 2017. http://unsdsn.org/wp-content/uploads/2014/09/US-Deep-Decarbonization-Report.pdf

13. Adam Cooper and Kellen Schefer, "Plug-in Electric Vehicles Sales Forecast Through 2025 and the Charging Infrastructure Required," The Edison Foundation - Institute for Electric Innovation, last modified June, 2017, accessed Sept 27, 2017. http://www.edisonfoundation.net/iei/publications/Documents/IEI_EEI%20PEV%20Sales%20and%20Infrastructure%20thru%202025_FINAL%20%282%29.pdf

14. Jack Ewing, "Volvo, Betting on Electric, Moves to Phase Out Conventional Engines," nytimes.com, last modified July 5, 2017, accessed Sept 13, 2017. https://www.nytimes.com/2017/07/05/business/energy-environment/volvo-hybrid-electric-car.html

- "GM Outlines All-Electric Path to Zero Emissions," General Motor Co., last modified Oct 2, 2017, accessed Oct 12, 2017. http://www.gm.com/mol/m-2017-oct-1002-electric.html

15. "Transportation Electrification: Reducing Emissions, Driving Innovation," pp. 8-9, Southern California Edison, last modified Jan 2017, accessed Oct 12, 2017. https://www.edison.com/content/dam/eix/documents/our-perspective/201701-transportation-electrification-reducing-emissions-driving%20innovation.pdf

16. Marc Melaina, Brian Bush, Joshua Eichman, Eric Wood, Dana Stringht, Venkat Krishnan, David Keyser, Trieu Mai, and Joyce McLaren, "National Economic Value Assessment of Plug-In Electric Vehicles Volume I," National Renewable Energy Laboratory, last modified Dec 2016, accessed Oct 12, 2017. https://www.nrel.gov/docs/fy17osti/66980.pdf

17. "Zero-Emission Vehicles," California Public Utilities Commission, accessed Oct 5, 2017. http://www.cpuc.ca.gov/General.aspx?id=5597

18. Marc Vartabedian, "Exclusive: Tesla's 'long-haul' electric truck aims for 200 to 300 miles on a charge," reuters.com, last modified Aug 24, 2017, accessed Oct 12, 2017. http://www.reuters.com/article/us-tesla-trucking-exclusive/exclusive-teslas-long-haul-electric-truck-aims-for-200-to-300-miles-on-a-charge-idUSKCN1B42GC

- "VW to develop electric trucks in $1.7 billion technology drive," reuters.com, last modified Oct 11, 2017, accessed Oct 12, 2017. https://www.reuters.com/article/us-autos-trucks-volkswagen-electric/vw-to-develop-electric-trucks-in-1-7-billion-technology-drive-idUSKBN1CG1VF

19. "New Residential Zero Net Energy Action Plan Vision Framework," 2020 Planning and Information for California ZNE Homes, accessed Oct 6, 2017. http://www.californiaznehomes.com/framework

20. For more information on job creation, see Appendix at sce.com/pathwayto2030

Electronic copies of this white paper and its appendices are available at sce.com/pathwayto2030

The Clean Power and Electrification Pathway

Realizing California's Environmental Goals

Appendices

November 2017

Contents

APPENDIX I: Pathway Analysis

Development Approach

The scope of the SCE Pathways Analysis was to identify the most feasible and economical pathway to realizing California's greenhouse gas (GHG) policy target in 2030, reducing emissions from all economic sectors by 180 million metric tons (MMT) — from 440 MMT in 2015 to 260 MMT in 2030 — and reducing air pollution to support achievement of health-based air quality standards.

The analysis resulted in the development of the Clean Power and Electrification Pathway. The Pathway includes the 132 MMT[1] of GHG abatement from the California Air Resources Board (CARB) Proposed Scoping Plan, in addition to 12 MMT of abatement obligations projected to be met by cap-and-trade offsets (4 percent of CARB's allotment for 2030). (See **Table 1.**) The GHG abatement from most of the current and expected policies identified in the CARB Proposed Scoping Plan are listed in **Table 2**.

Table 1. California GHG Accounting from CARB Policy

	GHG Accounting
2015 California Emissions (Economy Wide)	**440 MMT**
CARB Scoping Plan Update 2017	(132 MMT)
Cap-and-Trade Offsets	(12 MMT)
Cap-and-Trade Market / Incremental Abatement	(36 MMT)
2030 Emissions Target (40% below 1990 levels)	**260 MMT**

SCE used four criteria to select the GHG abatement measures for the Clean Power and Electrification Pathway (see **Table 3**) to abate the remaining 36 MMT needed to reach the 2030 GHG goal:

1. GHG abatement potential;
2. Marginal abatement costs[2];
3. Measure feasibility (availability of technology, infrastructure requirements, economies of scale, consumer preference, timing of deployment); and
4. Technologies that will continue to support GHG reductions beyond 2030 and help California achieve the 2050 GHG target (i.e., technologies with low risk of stranded investment by 2050).

The analysis to develop the Clean Power and Electrification Pathway, and alternative pathways, details the combination of measures (**see Table 4**) that could be implemented to achieve the 36 MMT of incremental abatement, incented by cap-and-trade.

This analysis used the Energy + Environmental Economics (E3) PATHWAYS model for deep decarbonization scenarios (https://www.ethree.com/tools/pathways-model/), as well as internally-developed economic adoption and renewable generation optimization models. These models produced an economy-wide view of the expected GHG abatement from existing and expected policies and forecasted economic adoption of low-carbon technologies and fuels. Results are in **Table 5**.

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[1] The CARB Proposed Scoping Plan calls for a number of initiatives and policies that would achieve 135 MMT of GHG abatement. However, AB 398 (2017) removed refinery efficiency improvements, accounting for 3 MMT of abatement. AB 398 also authorized the use of offsets to account for up to 12 MMT of emissions abatement.

[2] Marginal abatement costs refer to the cost of an additional unit of abatement, whereas incremental costs in this appendix refer to the cost of abating the final 36 MMT of GHG to meet California's 2030 climate goals.

Table 2. CARB-Identified Policy Impacts by Sector

Sectors	Initiatives and Policies	High-Level Description of Key Elements
Transportation	Low Carbon Fuel Standard	- 18% reduction in carbon intensity in fuel by 2030
	Mobile Source Strategy	- 1.5 million light-duty Zero Emission Vehicles (ZEV*) and Plug-in Hybrid Electric Vehicles (PHEV) by 2025 and 4.2 million ZEVs by 2030 - Medium- and heavy-duty GHG Phase 1 and 2 to reduce new vehicle emissions by 4 to 5% per year starting 2014 - Advanced Clean Transit: starting in 2018, 20% of new buses sold must be zero emission, increasing to 100% in 2030 - Last Mile Delivery: requirement to purchase low-NOx engines and phase-in zero emission trucks starting in 2020
	SB 375 Sustainable Community Strategies and Climate Protection Act of 2008	- Reduce Vehicle Miles Traveled (VMT) through greater access to alternative forms of transportation
	California Sustainable Freight Action Plan	- Improve freight system efficiency by 25% by 2030 - Deploy >100,000 freight vehicles and equipment capable of zero emission operation and maximize near-zero emission freight vehicles and equipment powered by renewable energy by 2030
	CARB Advanced Clean Cars	- By 2025, new vehicles will emit 75% less smog-forming pollutants and about one-half the GHG of the average new car sold today - Beyond 2025, 5% additional GHG emissions reductions are projected through new vehicle emissions standards - Zero Emission Vehicle Regulation requires ~15% of new cars sold in CA in 2025 to be PHEV, battery electric vehicles (BEV) or fuel cell vehicles
	Alternative Transportation	- Large Scale High Speed Rail
	Caltrans Complete Streets Implementation Action Plan	- Sustainable transportation facility for all users in rural, suburban, and urban areas
Electric Power	SB 350	- Increase the Renewables Portfolio Standard (RPS) to 50% by 2030 - Double additional achievable energy efficiency in electricity and natural gas end uses by 2030
	CPUC Rulemaking 13-09-011	- Improve Demand Response reliability and utility, in order to replace quick-start fossil-fueled generation
	AB 2514 and AB 2868	- AB 2514 requires investor-owned utilities (IOUs) to procure 1325 MW of energy storage by 2024, and AB 2868 requires an additional 500 MW
	SB 338	- Utilities are to identify carbon-free alternatives to gas generation for meeting peak demand in their integrated resources plans
Industrial	Governor Brown's Clean Energy Jobs Plan	- 6,500 MW of additional capacity from combined heat and power systems by 2030
Residential / Commercial	CPUC Long-term Energy Efficiency Strategic Plan	- Set policy goals to achieve zero net energy building (ZNE) in all new residential buildings by 2020, and all new commercial buildings by 2030
	Executive Order B-18-12	- State agencies to reduce grid-based energy purchases by at least 20% by 2018 - State agencies to reduce the GHG emissions associated with the operating functions of their buildings by 20% by 2020
	AB 758	- Requires CEC to develop and implement a comprehensive energy efficiency plan for all of California's existing buildings
Agriculture	SB 1383	- 40% reduction in methane & hydrofluorocarbon emissions by 2030 - 50% reduction in black carbon emissions by 2030
Total Scoping Plan GHG Reduction	**Combined effect of policies with cross-sector impacts**	**Approximately 132 MMT GHG Abatement**

*Zero emission vehicles primarily include Plug-in Hybrid Electric Vehicles, Hydrogen Fuel-cell Vehicles, and Battery Electric Vehicles.

GHG Abatement Methodology

Potential measures for additional GHG abatement from each economic sector were assessed across four key criteria and weighted based on their suitability for an optimized pathway to achieve the 2030 GHG goal.

Table 3 Legend

Marginal Cost	Low (green)	Medium (yellow)	High (red)
Abatement			
Feasibility	Low (red)	Medium (yellow)	High (green)
Enables 2050 Target			

Table 3. GHG Abatement Pathway Selection Criteria

Sectors	Measure	Marginal Cost †	Abatement Potential ‡	Feasibility	Enables 2050 Target ∆
Transportation	Light-Duty Hydrogen Fuel-Cell Trucks	Medium-High (orange)	Medium-High (light green)	Low (red)	Medium (yellow)
	Light-Duty Hydrogen Fuel-Cell Autos	Medium-High (orange)	Medium-High (light green)	Low (red)	Medium (yellow)
	Medium-Duty Hydrogen Fuel Cell Vehicles	Medium-High (orange)	Medium (yellow)	Low (red)	Medium (yellow)
	Electric Light-Duty Autos	Medium (yellow)	High (green)	High (green)	High (green)
	Electric Light-Duty Trucks	Medium (yellow)	High (green)	High (green)	High (green)
	Heavy-Duty Hydrogen Fuel Cell Vehicles	Medium (yellow)	Low-Medium (orange)	Low (red)	Medium (yellow)
	Light-Duty Plug-in Hybrid Autos	Medium (yellow)	High (green)	High (green)	High (green)
	Light-Duty Plug-in Hybrid Trucks	Medium (yellow)	High (green)	High (green)	High (green)
	Heavy-Duty Electric Vehicles	Medium (yellow)	Medium (yellow)	Medium (yellow)	High (green)
	Medium-Duty Electric Vehicles	Medium (yellow)	Medium (yellow)	High (green)	High (green)
	Medium-Duty Natural Gas Vehicles	Medium (yellow)	Medium (yellow)	High (green)	Low (red)
	Aviation Efficiency	Medium (yellow)	Medium (yellow)	Low (red)	Medium (yellow)
Electric Power	Hydrogen Pipeline Injection ¶	High (red)	Medium (yellow)	Low (red)	Medium (yellow)
	Rooftop Photovoltaic (PV)	High (red)	Medium (yellow)	Medium (yellow)	High (green)
	Renewable Diesel Production	Medium-High (orange)	High (green)	Medium (yellow)	Low (red)
	Large-Scale Renewable Generation	Medium (yellow)	High (green)	Medium-High (light green)	High (green)
	Biogas	Medium (yellow)	High (green)	Medium (yellow)	Medium (yellow)
Industrial	Process Cooling Efficiency	Medium (yellow)	Low (red)	Medium (yellow)	High (green)
	Boiler Efficiency	Medium (yellow)	Low (red)	Medium (yellow)	High (green)
	Process Heating Efficiency	Medium (yellow)	Low (red)	Medium (yellow)	High (green)
	HVAC Efficiency	Medium-High (light green)	Low (red)	Medium (yellow)	High (green)
	Lighting Efficiency	Medium-High (light green)	Low (red)	High (green)	High (green)
	Machine Drive Efficiency	Medium-High (light green)	Low (red)	Medium (yellow)	High (green)
Residential	Air Conditioning Efficiency	Medium-High (orange)	Low (red)	Medium (yellow)	High (green)
	Clothes Washer Efficiency	Medium-High (orange)	Low (red)	High (green)	High (green)
	Clothes Drying Efficiency	Medium (yellow)	Low (red)	High (green)	High (green)
	Refrigeration Efficiency	Medium (yellow)	Low (red)	High (green)	High (green)
	Dishwasher Efficiency	Medium (yellow)	Low (red)	High (green)	High (green)
	Heat Pump Water Heaters	Medium-High (light green)	Medium (yellow)	High (green)	High (green)
	Other Efficiency #	Medium-High (light green)	Low-Medium (orange)	Medium (yellow)	High (green)
	Air Source Heat Pumps	Medium-High (light green)	Medium (yellow)	High (green)	High (green)
	Lighting Efficiency	Low (green)	Low-Medium (orange)	High (green)	Medium (yellow)
	Freezer Efficiency	Low (green)	Low (red)	High (green)	High (green)
Commercial	Water Heating Electrification	Medium (yellow/orange)	Medium (yellow)	Medium (yellow)	High (green)
	Space Heating Electrification	Medium (yellow/orange)	Medium (yellow)	Medium (yellow)	High (green)
	Ventilation Efficiency	Medium-High (light green)	Low (red)	Medium (yellow)	High (green)
	Other Efficiency	Medium-High (light green)	Low-Medium (orange)	Medium (yellow)	High (green)
	Lighting Efficiency	Medium-High (light green)	Medium (yellow)	Medium (yellow)	High (green)
	Refrigeration Efficiency	Low (green)	Low-Medium (orange)	Medium (yellow)	High (green)

† An average Marginal Cost abatement curve represents a snapshot in time and a relative cost ranking of measures.

‡ Abatement potential represents total technical potential, rather than feasible potential.

∆ Likelihood that technology will enable California to meet its 2050 GHG emissions reduction goal.

¶ Restricted by a technical limit of 7 percent natural gas replacement.

Table 4. The Clean Power and Electrification Pathway Assumptions by Sector

	Measures	Measure Assumptions	Incremental GHG Abatement Contribution*	Full Path GHG Abatement Contribution*
Transportation	**Electric Light-Duty Autos** **Electric Light-Duty Trucks** **Light-Duty Plug-in Hybrid Autos** **Light-Duty Plug-in Hybrid Trucks** **Heavy-Duty Electric Vehicles** **Medium-Duty Electric Vehicles** **Medium-Duty Natural Gas Vehicles**	• Economic adoption alone drives 2MM of the 7 MM EVs necessary in 2030, requiring state and federal support for charging infrastructure and vehicles. • Increased EV adoption to at least 7 MM vehicles requires the extension of existing state and federal subsidies. EV growth will be driven by improved technology/lower costs, purchase incentives, charging infrastructure availability, consumer education and other measures. • Ridesharing is projected to grow by 20% through 2030. Policies that encourage the electrification of rideshare services can drive increased vehicle turnover and greater EV adoption. • On a per-vehicle basis, converting an ICE vehicle to an EV has significant air quality impacts, reducing NOx emissions by 98% for light duty and medium duty vehicles, and 84% for heavy duty vehicles, in addition to having no tailpipe emissions.	15 MMT	**58 MMT**
Electric Power	**Large-Scale Renewable Generation, Energy Storage, Energy Efficiency and Distributed Solar**	• Adding up to 30 GW of large scale renewable generation combined with existing large hydro facilities can enable 80% carbon-free electricity (determined through 2030 demand forecasts, less existing renewable generation contracts). • Expanding transmission and distribution infrastructure to accommodate large-scale and distributed generation. Adding up to 10 GW of energy storage for grid balancing, in addition to current mandates. • Full pathway abatement includes the doubling of energy efficiency and additional distributed solar as defined in CARB's Proposed Scoping Plan.	15 MMT	**56 MMT**
Industrial	**Reduction in Refinery (Calculated outside of Pathways)**	• Increase in EV adoption reduces petroleum demand and associated refining.	4 MMT	**30 MMT**
Residential	**Heat Pump Water Heaters** **Air Source Heat Pumps**	• Updating market costs and efficiency data, SCE calculated consumer adoption based on total cost of ownership. • Updated market data on cost plus policy-driven adoption in new construction leads to an increased adoption of high efficiency space and water heaters for residential buildings, totaling over 5 million units by 2030. Commercial space and water heating is also electrified and comprises 24% of thermal load. These represent up to 30% of space and water heaters expected in California in 2030.	2 MMT	**12 MMT**
Commercial	**Space Heating Electrification**			
Agricultural	**(Same as CARB Proposed Scoping Plan)**			**11 MMT**
Total			36 MMT	**180 MMT**

* **Incremental GHG Abatement Contribution** represents the GHG reductions from the identified technologies to meet the incremental 36 MMT of reductions after offsets to achieve California's 2030 GHG target. This 36 MMT reduction is incentivized by the cap-and-trade market under CARB's Proposed Scoping Plan. **Full Path GHG Abatement Contribution** represents both current and expected measures in CARB's Proposed Scoping Plan and the additional identified technologies used to meet the total 2030 GHG emission reduction goal.

Results Summary

Table 5 summarizes the three pathways. All scenarios include significant new electrification, in addition to major market transformations. (More information on the alternative pathways is detailed on page 6.)

Table 5. Comparing Decarbonization Pathways

	Clean Power and Electrification	Renewable Natural Gas (RNG)	Hydrogen (H2) Pathway
Carbon-Free Electricity Delivered	80%	60%	80%
Renewable Energy Over Generation	Managed through up to 10 GW of battery storage	Used to produce synthetic methane through "power to gas"	Used for hydrogen production from steam reforming and electrolysis
Transportation: Light-Duty Passenger Vehicles (EVs)	7MM EVs 24% of LDV stock	7MM EVs 24% of LDV stock	2MM EVs 4MM H2 fuel cell vehicles 22% of LDV Stock
	~13% reduction in transportation-related refinery throughout		
Transportation: Medium-Duty (MDV) and Heavy-Duty (HDV) Vehicles (Buses and Trucks)	9% MDVs, 6% HDVs are compressed natural gas (CNG)	12% MDVs, 12% HDVs are CNG	4% HDVs are H2 7% MDVs, 6% HDVs are CNG
	15% MDVs and 6% HDVs are EVs	7% MDVs and 1% HDVs are EVs	
Space and Water Heating (Residential and Commercial buildings)	Up to 30% electrification of space and water heating end uses	42% of natural gas replaced by RNG, 7% of natural gas replaced by H2	Up to 30% electrification of space and water heating end uses
Fuels and Other End Uses	7% of natural gas replaced by RNG		7% of natural gas replaced by H2 (technical limit)
Risks	- Most feasible pathway as technology already exists - Dependent on broad adoption of electrified technologies	- Power to gas not yet commercially available - A large biogas market requires expensive imports	- Most expensive pathway - Requires significant H2 adoption outside CA - Lack of sufficient delivery infrastructure
Average Abatement Cost (180 MMT)	$37/metric ton	$47/ metric ton	$70/metric ton
Incremental Abatement Cost (last 36 MMT)	$79/metric ton	$137/metric ton	$262/metric ton

Alternative Pathway 1: Renewable Natural Gas (RNG)

The RNG pathway includes the same assumptions as the CARB Proposed Scoping Plan with a few notable differences, which include:

- Higher percentage of MDV and HDV vehicles using compressed natural gas;
- Natural gas replaced in pipeline with RNG primarily from landfill capture and conversion, including the injection of hydrogen into the pipeline; and
- Renewable power over-generation is balanced on the grid through production of synthetic methane (power to gas), a technology that is not yet commercially available.

The RNG case requires less large-scale renewable generation because a large segment of the natural gas pipeline is replaced with RNG. Consequently, the cost per ton of abatement is higher due to the cost to procure and produce RNG, which would likely require significant imports into California.

Alternative Pathway 2: Hydrogen

The hydrogen pathway builds on the CARB Proposed Scoping Plan assumptions with the following differences:

- Hydrogen Fuel Cell Vehicles have higher adoption rates across two classes (light duty vehicles, medium duty vehicles);
- Hydrogen replaces pipeline natural gas for end uses up to the technical potential of 7 percent by volume (mid-range of 5-15 percent hydrogen concentration level defined in NREL's "Blending Hydrogen into Natural Gas Pipeline Networks: A Review of Key Issues"); and
- The addition of large-scale renewable generation in the hydrogen pathway is consistent with the generation capacity called for in the Clean Power and Electrification Pathway. Excess renewable generation during peak generation periods can be used in electrolysis to produce hydrogen, helping to balance the grid and reducing the need for energy storage.

The abatement cost of the Hydrogen Pathway is the highest among all three cases, due to the need for construction of hydrogen production infrastructure not currently present in California. Additionally, hydrogen production is energy intensive and its energy storage potential is limited. Infrastructure and production costs are embedded in the cost per ton.

APPENDIX II: Additional Information and Resources

Relevant Policies

Action	Authorization	Reference
Renewables Portfolio Standard (RPS): 20% by 2010 and then 33% by 2020	SB 1078 (2002)	Sen. Bill 1078, 2001-2002 1st Ex. Sess., ch. 516, *California State Legislature*, Sept 12, 2002. http://www.energy.ca.gov/portfolio/documents/documents/SB1078.PDF
	SB 107 (2006)	Sen. Bill 107, 2005-2006 1st Ex. Sess., ch. 464, *California State Legislature*, September 26, 2006. http://www.energy.ca.gov/portfolio/documents/documents/sb_107_bill_20060926_chaptered.pdf
	SB X1-2 (2011)	Sen. Bill X1 2, 2010-2011 1st Ex. Sess., ch. 1, *California State Legislature*, April 12, 2011. http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0001-0050/sbx1_2_bill_20110412_chaptered.html
Target established to reduce GHG emissions 80% below 1990 levels by 2050	Executive Order S-3-05 (2005)	California Executive Order S-3-05, June 2005. https://www.gov.ca.gov/news.php?id=1861
GHG emissions target of 1990 levels by 2020 is codified and economy-wide cap-and-trade program is created	AB 32 (2006)	Assem. Bill 32, 2005-2006 1st Ex. Sess., ch. 488, *California State Legislature*, Sept 27, 2006. http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf
Established RPS of 50% by 2030 and new requirements for doubling energy efficiency and wide-scale transportation electrification deployment	SB 350 (2015)	Sen. Bill 350, 2015-2016 1st Ex. Sess., ch. 547, *California State Legislature*, Oct 07, 2015. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB350
GHG target of reducing emissions 40% below 1990 levels by 2030 is codified	SB 32 (2016)	Sen. Bill 32, 2015-2016 1st Ex. Sess., ch. 249, *California State Legislature*, Sept 08, 2016. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201520160SB32
Cap-and-trade program extended to 2030 and new offset levels are defined	AB 398 (2017)	Assem. Bill 398, 2017-2018 1st Ex. Sess., ch. 398, *California State Legislature*, July 25, 2017. https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB398
CARB Proposed Scoping Plan to achieve the 2030 GHG target	CARB (2017)	AB 32 Scoping Plan, *California Air Resource Board*, last modified Jul 14, 2017, accessed Sept 13, 2017. https://www.arb.ca.gov/cc/scopingplan/scopingplan.htm
Low Carbon Fuel Standard to encourage the production and use of cleaner low-carbon fuels	Executive Order S-1-07 (2007)	*California Air Resource Board*, last modified Sept 8, 2017, accessed Sept 21, 2017. https://www.arb.ca.gov/fuels/lcfs/lcfs.htm
Zero Emission Vehicle (ZEV) Program	CARB (1990)	*California Resource Board*, last modified August 16, 2017, accessed Sept 21, 2017. https://www.arb.ca.gov/msprog/zevprog/zevprog.htm
"The Partnership for Sustainable Communities	U.S. Department of Housing and	*Sustainable Communities*, accessed Sept 21, 2017. https://www.sustainablecommunities.gov/partnership-resources/community-planning

Action	Authorization	Reference
(PSC) works to coordinate federal housing, transportation, water, and other infrastructure investments to make neighborhoods more prosperous, allow people to live closer to jobs, save households time and money, and reduce pollution. The partnership agencies incorporate six principles of livability into federal funding programs, policies, and future legislative proposals."	Urban Development (HUD), U.S. Department of Transportation (DOT), U.S. Environmental Protection Agency (EPA) 2009	

Additional Sources

CARB Scoping Plan

The 2017 climate change scoping plan update establishes a proposed framework of action for California to achieve a 40 percent GHG emissions reduction by 2030 compared to 1990 levels. The key programs under the proposed plan are the Cap-and-Trade market, the Low Carbon Fuels standard, movement toward cleaner vehicles, increasing electricity generation from renewable sources and strategies for methane emission reduction from agriculture.
https://www.arb.ca.gov/cc/scopingplan/scopingplan.htm

Energy Costs of GHG Emissions: National Pathway Clean Energy Study (NRDC)

NRDC's analysis shows that the United States can achieve 80 percent GHG emission reduction by 2050 from 1990 levels with only 1 percent cost increase compared with current U.S. energy cost. The key actions under the NRDC plan are: implement energy efficiency technologies to reduce energy demand by 40 percent, expand renewable energy to achieve 70 percent RPS by 2050, employ near-zero carbon electricity to displace fossil fuel usage in transportation, residential and commercial buildings and industry, and decarbonize remaining fuel use in transportation and industry.
https://www.nrdc.org/sites/default/files/americas-clean-energy-frontier-es.pdf

EV Market Trends

Electric cars sales are forecasted to surpass internal combustion engine sales by 2038 because electric cars could be cost competitive with gasoline models by 2025, battery manufacturing capacity will continue to grow, and lithium-ion cell cost will decline significantly. The global shift toward electric vehicles will create upheaval for the auto industry, will increase EV electricity consumption from 6 terawatt-hours in 2016 to 1800 terawatt-hours in 2040, and will affect the oil industry through gasoline demand reduction.
https://www.bloomberg.com/news/articles/2017-07-06/the-electric-car-revolution-is-accelerating

Electric vehicles are becoming increasingly common, with automakers indicating that about 70 EV passenger models will likely be available within five years. Key factors driving additional purchases of electric cars are that electric cars use far less energy than gasoline-powered cars, cost less to run and have lower maintenance costs. Limited variety among electric vehicles, high price premium and limited range are among the barriers that prevent people from purchasing EVs.
https://www.consumerreports.org/hybrids-evs/electric-cars-101-the-answers-to-all-your-ev-questions/

Mass-produced electric vehicles first entered the market late in 2010, with the benefit of high performance, safety, versatility and ability to conveniently charge at home at a low cost. Displacing gasoline with electricity also lowers emissions and decreases petroleum use. The challenge to consumers is to understand their own driving needs and how each vehicle option can meet their specific requirements as more options become available.
https://www.epri.com/#/pages/product/1023161/

Job Creation

The Bureau of Labor Statistics projects that solar PV installers and wind turbine service technicians will be the fastest growing occupations in the US from 2016 to 2026.
https://www.bls.gov/news.release/pdf/ecopro.pdf?utm_source=newsletter&utm_medium=email&utm_campaign=newsletter_axiosgenerate&stream=politics

According to a UC Berkeley report, 10,200 job years (one full time job for one year) have been created in the solar industry in California in the five years ending in 2014; in 2014, the average salary for these jobs was $78,000 per year plus benefits.
http://laborcenter.berkeley.edu/environmental-and-economic-benefits-of-building-solar-in-california-quality-careers-cleaner-lives/

CAISO's Senate Bill (SB) 350 report concluded that an additional 90,000 – 110,000 statewide jobs would be created from the 50% Renewables Portfolio Standard and also projected higher statewide gross product, real output, and state revenue across all the scenarios studied.
http://www.caiso.com/Documents/SB350Study-Volume8EconomicImpacts.pdf

The Southern California Association of Governments 2016-2040 Regional Transportation Plan is projected to create 351,000 additional jobs (in part from transportation electrification strategies).
http://scagrtpscs.net/Documents/2016/final/f2016RTPSCS.pdf

A report issued by the Union for Concerned Scientists and Greenlining Institute, reports that "California's heavy-duty EV sector is an emerging job market," and that family-supporting jobs will be available in maintenance, charging infrastructure and truck and bus manufacturing.
http://www.ucsusa.org/sites/default/files/attach/2016/10/UCS-Electric-Buses-Report.pdf

NRDC research finds that "today's automotive sector provides a powerful example of how we can simultaneously meet the nation's environmental, economic, and job-creation goals." Currently, 288,000 American workers are "building technologies that reduce pollution and improve fuel economy for today's innovative vehicles, from family sedans to long-haul tractor trailers."
https://www.nrdc.org/sites/default/files/supplying-ingenuity-clean-vehicle-technologies-report.pdf

Appendix B

California GHG Abatement Cost and Opportunity Curve

California GHG abatement cost and opportunity, by measure
$/metric ton[1]

Commercial Refrigeration Efficiency, (835)
Residential Freezer efficiency, (725)
Residential Lighting Efficiency, (675)
Commercial Lighting Efficiency, (557)
Other Commercial Efficiency, (513)
Residential Air Source Heat Pumps, (393)
Other Residential Efficiency, (345)
Aviation Efficiency, (309)
Industrial Machine Drive Efficiency, (308)
Industrial Process Heating Efficiency, (149)
Industrial Boiler Efficiency, (133)
Heavy-Duty Electric Vehicles, (96)
Plug-In Hybrid Light-Duty Trucks, (76)
Plug-In Hybrid Light-Duty Autos, (76)
Residential Clothes Drying Efficiency, (61)
Hydrogen Fuel-Cell HDV, (55)
Biogas, 26

Industrial
Transportation
Energy supply
Commercial
Residential

50 MMTs

Hydrogen Pipeline Injection^, 2,803
Hydrogen Fuel-Cell Light-Duty Trucks, 1,237
Hydrogen Fuel-Cell Light Duty Autos, 825
Commercial Water Heating Electrification, 332
Residential Dishwasher Efficiency, 302
Commercial Space Heating Electrification, 245
Renewable Diesel Production, 420
Renewable Portfolio Standard, 212
Electric Light-Duty Autos, 89

Marginal cost of abatement ($/ton)

3,000
2,500
2,000
1,500
1,000
500
-
(500)
(1,000)

Residential Refrigeration Efficiency, 50
Industrial Process Cooling Efficiency, 59
Medium-Duty Electric Vehicles, (184)
Industrial HVAC Efficiency, (204)
Residential Heat Pump Water Heaters, (241)
Industrial Lighting Efficiency, (268)
Commercial Ventilation Efficiency, (291)
NG MDVs, (297)

Electric Light-Duty Trucks, 88

Rooftop PV, 2,791
Residential Clothes Washer Efficiency, 437
Residential Air Conditioning Efficiency, 556
Medium-Duty Hydrogen Fuel Cell Vehicles, 817

1 Averaged over a 10 year period
Note: - The average abatement curve is one of many tools in developing an optimal path for decarbonization. It represents only a snapshot in time and relative rankings of measures.
      - Abatement potential represents total technical potential, rather than feasible potential.

Appendix C

GAM/PMM Portfolio Treatment

GAM/PMM Portfolio Treatment

On April 2, 2018 in the PCIA reform proceeding, R.17-06-026, the three IOUs served testimony proposing to replace the current PCIA with a GAM and PMM. For the SCE Preferred Portfolio, SCE uses a cost allocation method consistent with the GAM/PMM proposal, as briefly outlined in the following chart.

TOTAL ELIGIBLE PORTFOLIO

GREEN ALLOCATION MECHANISM (GAM)

PORTFOLIO
Vintaged: RPS-eligible resources and Large Hydro
Non-Vintaged: Mandated procurement independent of load/need (e.g. tariffs, tech carve-outs, standard contract)

ALLOCATIONS
- Pro rata quarterly allocation of RECs based on actual load
- Monthly allocation of RA based on peak load share
- Allocation of future benefits that may come into existence with policy or market development

CHARGE
- Actual costs incurred less actual market revenues
- Rates set in ERRA Forecast and trued-up in balancing account

PORTFOLIO MONETIZATION MECHANISM (PMM)

PORTFOLIO
Vintaged: Gas, Nuclear, (non-pumped hydro) Energy Storage
Non-Vintaged: Mandated procurement independent of load (e.g. QF)

ALLOCATIONS
- No allocations of attributes

CHARGE
- Transition charge similar to PCIA that's not dependent upon administratively-set benchmarks
- Above-market costs reflect actual energy and RA capacity revenues realized in the market
- Departing load share of RA monetized with unsold attributes valued at $0.

Appendix D.1

New Resource Data Template – SCE Pathway System Plan

SEE NOTICE OF AVAILABILITY FOR
APPENDIX D.1

Appendix D.2

New Resource Data Template – SCE Preferred Portfolio

SCE IRP Load and Demand-Side Resource Inputs and Assumptions

This document contains the load and demand-side resource assumptions and data sources used in the SCE Preferred Portfolio in SCE's IRP. The structure and tables presented utilized the Commission/E3 RESOLVE documentation as a template. All demand forecasts presented in this section reflect demand at the customer meter.

The SCE Preferred Portfolio was developed for SCE's bundled share of the SCE Pathway System Plan. In accordance with D.18-02-018, SCE prepared load and load modifiers assumptions using the standard IRP filing form templates. As part of the 2017 IEPR process, the majority, if not all, of the load modifiers were submitted at the SCE retail level. Therefore, the tables in this document containing load modifier information will be presented at the bundled level and the retail level for purposes of comparing the differences from what SCE filed with the CEC as part of its 2017 IEPR submittal.

Load Forecast

SCE's 2017 Retail Sales Forecast

SCE uses econometric models to develop its retail sales forecast – a forecast of monthly retail electricity sales (billed recorded sales measured at the customer meter) by customer class. Retail sales are final sales to bundled, direct access ("DA"), and CCA customers. DA and CCA sales are subtracted from the retail sales forecast in order to derive the forecast of SCE bundled service customer sales. Retail sales exclude sales to public power customers, contractual sales, resale city sales, municipal departing load, and inter-changes with other utilities.

The retail sales forecast represents the sum of sales in six customer classes: residential, commercial, industrial, public authority, agriculture, and street lighting. Each customer class forecast is itself the product of two separate forecasts: a forecast of electricity consumption and a

forecast of the number of customers.[1] Customer class data are used because they have been

defined in a consistent manner throughout the sample period used in the econometric estimation.

In addition to the categorization by customer class, residential sales are further modeled

and forecasted according to geographical region. The SCE service area encompasses several

distinct climate zones. Accordingly, SCE models residential electricity consumption in part to

capture regional variation in the weather/consumption relationship.

The electricity consumption per customer or per square foot forecasts are produced by

statistical models that are based upon measured historical relationships between electricity

consumption and various economic factors that are thought to influence electricity consumption.

The estimation procedure used to construct these statistical models is ordinary least squares.

Another set of econometric equations are used to forecast customers by customer class (in most

cases customer additions are modeled (the change in the number of customers in the current

month and the previous month) and converted into a forecast of total customers).

The regression equations, combined with forecasts of various economic drivers, such as

employment and output, along with normal weather conditions and normal number of days

billed, are used in combination to predict sales by customer class. Model-generated forecasts

may be modified based on current trends, judgment, and events that are not specifically modeled

in the equations.

1.   Baseline Consumption

"Baseline Consumption" is used to refer to the counterfactual forecast of the consumption

of electricity, in the absence of load modifiers. The derivation of the Baseline Consumption

from the bundled sales of SCE's retail sales forecast is shown in Table 1.

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[1]   Electricity usage of residential, agriculture, commercial, and streetlights service accounts is
       forecasted by consumption per customers. Electricity usage of industrial and public authority service
       accounts is forecasted by usage per square footage.

Table 1 Baseline Consumption from SCE's 2017 Bundled Sales Forecast (GWh)

Component	2018	2022	2026	2030
SCE 2017 Bundled Sales		44,246	43,006	42,908
+ Mid High Plus AAEE		3,564	6,880	10,598
+ Non- PV Self Generation		3,124	3,302	3,490
+ BTM PV		5,017	7,625	9,402
- Light-duty EVs		1,229	3,387	5,812
- Medium-duty EVs		56	152	246
- Heavy-duty EVs		22	64	105
- Off-Road Transportation Electrification		445	557	671
- Building Electrification		506	751	1,067
Baseline Consumption		**53,693**	**55,903**	**58,497**

Load Modifiers

2. Transportation Electrification

SCE forecasts future transportation electrification ("TE") load growth for both LDV load and non-LDV load. Non-LDV load includes MDV, HDV, and off-road vehicle TE.[2]

SCE models the light-duty EVs through a Generalized Bass Diffusion model.[3] The Bass Diffusion model originally developed in 1969 is a method in forecasting new technology adoptions.[4] The SCE model estimates the impact from total cost of ownership ("TCO") for EVs relative to the TCO of internal-combustion engines. The SCE model also considers the impact from customers' range anxiety effect using the CEC's average vehicle range forecast as its explanatory variable.[5] SCE utilizes American Community Survey to estimate the maximum

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[2] SCE's off-road TE forecast accounts for forklifts, truck stop electrification, transport refrigeration units, port cargo handling equipment, and airport ground support equipment.

[3] *See* Bass, Frank M., Trichy V. Krishnan, Dipak C. Jain, *Why the Bass Model Fits Without Decision Variables*, Marketing Science, Vol. 13, No. 3, Summer 1994.

[4] *See* Bass, Frank M., *A New Product Growth for Model Consumer Durables*, Management Science, Vol. 15, Issue 5, 1969.

[5] Bahrenian, Aniss, Jesse Gage, Sudhakar Konala, Bob McBride, Mark Palmere, Charles Smith, and Ysbrand van der Werf, *Revised Transportation Energy Demand Forecast, 2018-2030*, CEC, Publication Number: CEC-200- 2018-003, 2018.

potential for future likely EV adopters.[6] The SCE Preferred Portfolio projects a retail level share

of around 2.59 million light-duty EVs by 2030, out of the 6.8 million light-duty EVs in the SCE

Pathway System Plan.

For all non-LDV forecasts which include MDV, HDV, and off-road TE, SCE bases its

service area forecasts on the "in-between" forecasts from ICF International and E3's *California*

Transportation Electrification Assessment, Phase 1: Final Report.[7]

Table 2.1 TE Forecast (GWh) Bundled Customers

Component	2018	2022	2026	2030
Light-duty EVs		1,229	3,387	5,812
Medium-duty EVs		56	152	246
Heavy-duty EVs		22	64	105
Off-Road TE		445	557	671
Total TE		**1,752**	**4,160**	**6,834**

Table 2.2 TE Forecast (GWh) Retail Level

Component	Vintage	2018	2022	2026	2030
Light-duty EVs	**SCE Preferred Portfolio**	**590**	**1,985**	**5,442**	**9,409**
	2017 IEPR Submittal	**893**	**3,102**	**5,665**	**7,535**
Medium-duty EVs	**SCE Preferred Portfolio**	**10**	**91**	**244**	**398**
	2017 IEPR Submittal	**N/A**	**N/A**	**N/A**	**N/A**
Heavy-duty EVs	**SCE Preferred Portfolio**	**2**	**36**	**103**	**170**
	2017 IEPR Submittal	**N/A**	**N/A**	**N/A**	**N/A**
Off-Road TE	**SCE Preferred Portfolio**	**569**	**718**	**895**	**1,087**
	2017 IEPR	**N/A**	**N/A**	**N/A**	**N/A**

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[6] SCE uses socio-economic data for California, such as household vehicle size and structure, income levels, and educational attainment, from the American Community Survey data collected by the U.S. Census Bureau, available at: https://www.census.gov/programs-surveys/acs/.

[7] *See* ICF International and E3, *California Transportation Electrification Assessment, Phase 1: Final Report*, August 2014, updated September 2014, at 15-16, available at: http://www.caletc.com/wp-content/uploads/2016/08/CalETC_TEA_Phase_1-FINAL_Updated_092014.pdf.

Component	Vintage	2018	2022	2026	2030
	Submittal				

Given the uncertainty around future policy impacts on non-electrification measures and strong consumer preferences toward EVs predicted by the adoption models, SCE believes that higher level of EV adoption forecast is supportive of state's climate goals. Some of the driving factors of higher EV adoption include a significant decline in battery cost, lower price tags, and increased EV models. EV adoption is also supported by policies such as Executive Order B-48-18, issued by California Governor Jerry Brown that sets a target of getting 5 million zero-emission vehicles on the roads in California by 2030, and the utilities' infrastructure investments and programs.

3. Building Electrification

As outlined in the SCE Pathway System Plan, SCE derived its building electrification load assumption from its economy-wide PATHWAYS GHG scenario analysis results regarding the optimal level of electrification of 30% residential space and water heating pumps and 30% commercial space heating in California by 2030. SCE believes that its building electrification forecast is more reasonable compared to the CEC's 2017 IEPR, which reflects no building electrification.

Table 3.1 Building Electrification Forecast (GWh) Bundled Customers

Component	2018	2022	2026	2030
Building Electrification		506	751	1,067

Table 3.2 Building Electrification Forecast (GWh) Retail Level

Component	Vintage	2018	2022	2026	2030
Building Electrification	SCE Preferred Portfolio	607	817	1,206	1,727
	2017 IEPR Submittal	N/A	N/A	N/A	N/A

4. BTM PV

Consistent with the SCE Pathway System Plan, SCE models the residential adoption of PV through a Generalized Bass Diffusion model. The SCE model uses percentage changes in the price-per-watt-AC of installation, adjusted for the Federal Investment Tax Credit, as its

explanatory variable. Bloomberg New Energy Finance provided SCE's historical and forecast solar installation price series from 2010-2030.[8] The compound monthly growth rate was used to extend this series back to 2000. Residential PV adoption history comes from SCE's internal net energy metering ("NEM") database.

As this model is essentially a regression, expected policy changes in the future that are not reflected in the history require post-model adjustment. Additional estimates were performed to account for future PV installation in compliance of future zero-net energy ("ZNE") home policy.

Several post-model adjustments are implemented:

a) From 2018 to 2022, the annual incremental adoptions were decreased by 2.35% to reflect the effect of the implementation of the new NEM 2.0, which started on July 1, 2017. The reason of the end year being 2022 is that the potential NEM 3.0 is predicted to launch around 2022.

b) ZNE single family home policy compliance rates were assumed to increase to 85% by 2022. The ramping compliance rate to the ZNE series are 10% in 2018, 25% in 2019, 50% in 2020, 75% in 2021, 85% in 2022 and so on.

c) ZNE multi-family home policy compliance rates were assumed to be uniformly 20% starting 2020.

SCE then converts the residential installation numbers into kilowatts ("kW") by multiplying 5.2 kW, which is the historical average kW per installation across the whole SCE service area.

Given the limited impact of the non-residential sector on the overall forecast, SCE currently employs a basic approach. For this portion, SCE utilizes historical trend analysis combined with expert judgment to project the non-residential PV growth. SCE then convert

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[8]   *See* Bloomberg New Energy Finance, *1H 2017 U.S. PV Market Outlook* data set, June 2017.

installations into kW by multiplying 160 kW (historical average) for organic adopters and 246 kW (expert judgment) for ZNE customers (mandatory after 2030).

Table 4.1 BTM PV Forecast (GWh) Bundled Customers

Component	2018	2022	2026	2030
BTM PV		5,017	7,625	9,402

Table 4.2 BTM PV Forecast (GWh) Retail Level

Component	Vintage	2018	2022	2026	2030
BTM PV	SCE Preferred Portfolio	4,004	7,833	11,949	14,751
	2017 IEPR Submittal	2,577	8,546	11,789	13,661

5. Non-PV Self Generation

The forecast of customer on-site bypass self-generation is calculated from SCE's thermal lists of customers operating generating systems interconnected to the SCE grid for the purpose of meeting their own energy requirements. Thermal lists identify those customers that have BTM systems on-line, under construction or current plans to install. The description of each facility includes designation of customer class, nameplate capacity in kW, probable bypass kW, capacity factor, and online date.

Table 5.1 Non-PV Self Generation Forecast (GWh) Bundled Customers

Component	2018	2022	2026	2030
Non-PV Self Generation		3,124	3,302	3,490

Table 5.2 Non-PV Self Generation Forecast (GWh) Retail Level

Component	Vintage	2018	2022	2026	2030
Non-PV Self Generation	SCE Preferred Portfolio	4,875	5,192	5,507	5,825
	2017 IEPR Submittal	5,233	5,542	5,848	6,160

6. Energy Efficiency

For energy efficiency ("EE"), SCE is following the CEC staff's recommendation for the SCE Pathway System Plan and SCE Preferred Portfolio: "Staff recommends Scenario 6 (Mid

High Plus AAEE) be used by CPUC and ISO when assessing high EE savings futures in IRP and transmission planning studies, and by CARB in GHG Scoping Plan assessments."[9]

Table 6.1 EE Forecast (GWh) Bundled Customers

Component	2018	2022	2026	2030
EE: Mid High Plus AAEE		3,564	6,880	10,598

Table 6.2 EE Forecast (GWh) Retail Level

Component	Vintage	2018	2022	2026	2030
EE: Mid High Plus AAEE	SCE Preferred Portfolio	1,217	5,929	11,484	17,710
EE: Mid AAEE	2017 IEPR Submittal	1,221	3,417	8,238	10,834

CEC staff made adjustments to future ratchets of standards in the SB 350 analyses beyond those included in traditional AAEE. These ratchets include adjustments for naturally occurring market adoptions, compliance rates, and an additional "uncertainty factor" reflecting realized versus expected savings, derived from the Commission's Evaluation, Measurement, and Verification studies.

7.   **Demand Response**

SCE's Load Modifying Demand Response ("LMDR") forecast reflects ex-ante estimates based on the Load Impact Protocols. The protocols governing the development of ex-ante load impacts were designed to help ensure that demand response impact estimates would be directly comparable with other resource alternatives (i.e., other demand response resources, EE, renewables, and generation).

The SCE Preferred Portfolio, SCE's 2017 IEPR submittal, and CEC staff base LMDR estimates on the Commission's annual load impact filing:

- Southern California Edison 2016 Demand Response Portfolio Summary Report, April 1, 2017

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[9]   *See* CEC, *Role of SB 350 Energy Efficiency Savings in 2017 IEPR AAEE Scenarios*, December 15, 2017, at 32, available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=221979.

Load Shape Modeling

8. SCE Load Shape

SCE load shape modeling is based on the creation of system load and CCA load shapes. First, a system shape is derived. This is done by incorporating three years of historical weather and load data and other variables into hourly regression models to calibrate the model regression coefficients. The resulting system load shape is based on the regression coefficients and weather assumptions from the 30 years historical weather data and calendar variables for futures years to forecasts the hourly load. The load shape allows for future forecasting.

The next step is to create hourly DER forecasts based on DER forecasts of annual energy and their own future shapes. Once an overall consumption forecast is produced using the system load shape and DER forecasts, hourly DER load is subtracted from hourly consumptions to generate an hourly net load shape.

9. CCA load shape

SCE derives its CCA load forecast by forecasting individual CCA entities (incorporated cities or unincorporated counties) that are assumed to begin CCA service in the near term and running a Monte Carlo simulation of likely additional CCA formation based on CCA activity-based probabilities to forecast longer term.[10] In some cases, such as CCA phase-in periods, a single CCA entity may be divided into more than one segment (e.g., municipal, residential, non-residential).

For most CCA entities and aggregations expected to begin service by the end of 2019, two years of hourly data (2016 and 2017) were available for recent CCA load forecasting efforts. SCE averaged hourly load between 2016 and 2017, adjusting for days of the week and leap year to derive an adjusted 2017 hourly load shape. SCE calculated a monthly peak based on top five

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[10] SCE's forecasting criteria for assumed near-term CCA departure includes: 1) filing of a binding notice of intent to begin CCA service; 2) initial RA filing; 3) start of CCA service; or 4) formal submission of an April RA forecast for the following year pursuant to Public Utilities Code Section 380.

hourly load of the derived 8,760 (hours), then adjusted the derived load shape based on the peak adjustment so that monthly energy is consistent.

The 2017 adjusted hourly shape is used to assign the hourly load to 2018 and 2019 based on the calendar variables. The resulting hourly loads are used to calculate the CCA load shapes for 2018 and 2019. SCE uses 2017 actual load and forecasted retail residential and non-residential growth rates to forecast annual energy for each CCA entity. This forecasted annual energy and CCA load shapes are used to create hourly forecasts for the first two years of the forecast (e.g., 2018 and 2019). For the period beyond the first two years of the CCA forecast (2020 for recent forecasts), total CCA load is a sum of CCA entities and the run of a Monte Carlo simulation. Total CCA annual load is applied to SCE non-DA load shape to create hourly CCA forecasts.

SEE NOTICE OF AVAILABILITY FOR CONTINUATION OF PUBLIC VERSION OF APPENDIX D.2

Appendix D.3

New Resource Data Template – SCE Conforming Portfolio

SEE NOTICE OF AVAILABILITY FOR
APPENDIX D.3

Appendix E.1

Baseline Resource Data Template – SCE Preferred Portfolio

SEE NOTICE OF AVAILABILITY FOR
PUBLIC VERSION OF APPENDIX E.1

Appendix E.2

Baseline Resource Data Template – SCE Conforming Portfolio

SEE NOTICE OF AVAILABILITY FOR
PUBLIC VERSION OF APPENDIX E.2

Appendix F

SCE's CNS Calculation Methodology

SCE's CNS Calculation Methodology

This Appendix outlines SCE's approach to estimating GHG, NOx, and PM2.5 emissions attributable to its bundled load for both its SCE Preferred and Conforming Portfolios.

Background

On May 25, 2018, the Commission adopted a CNS methodology and CNS Calculator to facilitate demand-based GHG emissions reporting in the IRP process.[1] The CNS Calculator assigns GHG emissions to each LSE on an hourly basis, by first calculating an LSE's CNS position (i.e., how much its planned clean energy supply falls short of meeting its load in a given hour), and then multiplying each LSE's hourly CNS position, less non-dispatchable emitting resources, by the hourly GHG emissions intensity of the CAISO system. The hourly GHG emissions intensity of the CAISO system reflects the total GHG emissions (in tons) divided by the total electricity generation (in MWh) of unspecified imports and dispatchable gas generators, as estimated in RESOLVE for the Commission's Reference System Plan. Notably, the Commission's CNS methodology does not consider the minimum gas generation requirement to support system reliability, resulting in a zero (or near zero) system-level emissions intensity during mid-day high solar production hours.

In D.18-02-018, the Commission stated that "[t]o the extent possible, we will endeavor to request local air pollutant reporting that is similar to or parallel to the methodology used for reporting GHG emissions associated with LSE load and portfolios, since both GHG and local air pollutant emissions are associated with the same physical act of burning fuel in power plants."[2] Subsequent guidance from Commission staff provided that "LSEs are permitted, but not required, to use the CNS methodology and the CNS Calculator in estimating criteria pollutants

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[1] *See Administrative Law Judge's Ruling Finalizing Greenhouse Gas Emissions Accounting Methods, Load Forecasts, and Greenhouse Gas Benchmarks for Individual Integrated Resource Plan Filings*, R.16-02-007, May 25, 2018.

[2] D.18-02-018 at 69.

associated with using system power. LSEs doing so should provide an explanation of how they derive their estimates."[3]

SCE utilized the CNS methodology and CNS Calculator for estimating GHG, NOx, and PM2.5 emissions associated with its portfolios. For the SCE Conforming Portfolio, SCE used the Commission's CNS calculator without modification to estimate GHG emissions. SCE modified the CNS Calculator as described in this Appendix to estimate NOx and PM2.5 emissions associated with the SCE Conforming Portfolio. For the SCE Preferred Portfolio, SCE modified the CNS calculator for GHG, NOx, and PM2.5 emissions as described in this Appendix.

In comments on the proposed CNS methodology and CNS Calculator, the IOUs identified a need to include emissions from GHG-emitting resources that need to run at specified minimum levels to be available for the evening ramp (i.e., Pmin generation) in future iterations of the CNS Calculator.[4] In the course of developing the SCE Preferred Portfolio, SCE developed versions of the CNS Calculator that incorporate Pmin generation, to calculate the system emissions intensities for GHG, NOx, and PM2.5 emissions based on its PLEXOS production cost simulation modeling results. In addition, SCE enhanced this CNS methodology to account for NOx emissions attributable to both steady state operations and unit starts and stops.

Including Pmin emissions in the CNS Calculator results in generally higher system emissions intensities for certain hours of the day (i.e., high solar production hours) because operating these units at minimum levels is, while required for system reliability, fuel inefficient. SCE's analysis also shows that the Commission's current CNS methodology and CNS Calculator

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[3] *Integrated Resource Planning (R.16-02-007) Filing Requirements Reference Guide*, July 20, 2018, at 9, available at:
http://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/irp/2018/LSE_Filing_ReferenceGuide_20180720.pdf.

[4] *See Comments of Pacific Gas And Electric Company (U 39-E), San Diego Gas & Electric Company (U 902-E), and Southern California Edison Company (U 338-E) to Administrative Law Judge's Ruling Seeking Comment on Greenhouse Gas Emissions Accounting Methods and Addressing Updated Greenhouse Gas Benchmarks*, R.16-02-007, April 20, 2018, at 7.

may over-allocate oversupply emissions credits to LSEs, in particular when Pmin emissions are added into the tool.

SCE discusses proposed modifications to the CNS methodology and CNS Calculator in Section VI.B.1.c of this IRP. The remainder of this Appendix discusses SCE's CNS calculation methodology for incorporating Pmin, PM2.5, and NOx emissions into the CNS Calculator to measure emissions associated with its portfolios.

PLEXOS Production Cost Simulation for CNS

SCE used PLEXOS, a commercial software program developed by Energy Exemplar, to develop hourly GHG, NOx, and PM2.5 system emissions intensities for both the Commission's Reference System Plan and the SCE Pathway System Plan. This is a California-only zonal model based on the full network model published by the CAISO on a regular basis.

SCE calculated the system emissions intensities using the PLEXOS production cost simulation modeling results for three main reasons. First, SCE's PLEXOS production cost simulation model considers the detailed generator characteristics, ramping capabilities, and minimum gas generation requirements to support system reliability, all of which results in more accurate emissions estimates. Second, the Commission only established the GHG emissions intensity for its Reference System Plan, and these system-level values were not applicable to the SCE Preferred Portfolio. The SCE Preferred Portfolio represents SCE's bundled share of a cleaner system, in line with a lower 2030 electric sector GHG emissions planning target of 28 MMT, instead of 42 MMT. Finally, the Commission did not publish the system emissions intensities for NOx and PM 2.5, for either the Reference System Plan or a plan more closely reflecting the SCE Preferred Portfolio goals.

In Table F-1 below, SCE compares the 2030 generation results from PLEXOS production cost simulation and RESOLVE modeling for the Reference System Plan. The annual electricity generation from the GHG-emitting resources, including gas, cogeneration, and unspecified imports, are similar between PLEXOS and RESOLVE. This demonstrates that it is reasonable to use PLEXOS production cost simulation modeling results for CNS calculations of GHG, NOx

and PM2.5 emissions for the SCE Preferred Portfolio, and CNS calculations of NOx and PM2.5 emissions for the SCE Conforming Portfolio. For calculating the GHG emissions of SCE's Conforming Portfolio, SCE used the default emissions factors in the Commission's original CNS calculator.

Table F-1
Comparison of PLEXOS and RESOLVE Results for CAISO System Electricity Generation by Resource Type in 2030 for Reference System Plan

Generation (GWh)	PLEXOS	RESOLVE
Gas	71,099	70,989
Cogeneration	14,054	14,759
Renewables	105,545	105,418
Hydro	21,363	20,931
Storage	2,461	2,395
CAISO Imports	12,224	11,310
Palo Verde Imports	5,563	5,004
CAISO Exports	-7,675	-5,880

GHG Calculation Methodology for SCE Preferred Portfolio

SCE used the hourly gas generation and unspecified CAISO imports results in Tables F-2 and F-3 below to calculate hourly emissions intensity factors (tons/MWh) attributable to the SCE Pathway System Plan, by dividing the GHG emissions (tons) for each hour by the total MWh generation from the dispatchable gas generators and unspecified imports in the same hour. A GHG emissions rate of 0.428 MT CO2e/MWh was applied to unspecified CAISO imports, consistent with the Commission's assumptions.

Table F-2
PLEXOS Production Cost Simulation Month-Hourly Gas Generation in 2030 (MWh) – SCE Pathway System Plan

	1	2	3	4	5	6	7	8	9	10	11	12
1	339256	276360	227552	200911	194221	246442	306741	409447	300482	280274	290036	382431
2	339457	278641	226565	201212	196054	242147	299583	400756	295159	276887	287134	382496
3	336704	276687	223714	196587	191612	233415	292387	393763	291441	270931	284412	380715
4	333391	272147	219946	195277	190398	232533	292375	391811	289698	268120	280742	375206
5	331122	271916	220480	199967	187035	220562	284037	393178	292536	271343	278953	371427
6	335766	276449	223451	177992	130977	113012	199104	357433	278386	277513	284164	375047
7	344985	284945	179752	36900	31191	29551	39667	107838	101736	211427	281052	384316
8	322970	206091	48408	29442	30381	32592	36762	64469	30220	35546	131974	347501
9	107798	48005	27905	20420	22144	30924	36579	68593	27565	25872	39521	116031
10	88416	35558	23638	20420	22155	37238	44872	84169	27538	26962	39590	79402
11	54628	41216	23655	20420	22153	33066	39179	75693	29262	26851	32111	70787
12	52465	38695	23397	20376	22155	39065	57219	79482	29546	26764	34060	67074
13	52057	30702	23241	20420	22200	32977	90585	117345	30936	26783	34051	66338
14	52667	35563	23397	20420	23286	34253	99606	112975	31164	26970	32187	66729
15	52902	45546	23148	20420	22499	35937	55767	113240	29360	27561	32657	69580
16	59066	31657	23618	20327	22520	31595	68860	150349	57483	29920	37271	94339
17	256249	67208	24777	27493	24483	39731	129597	242628	167184	201075	225990	319452
18	281934	199091	138592	109571	55098	110923	228001	378260	255923	223663	242801	342705
19	284606	210925	148151	132940	122650	199621	270901	400967	265146	226602	245888	345582
20	284605	211838	148867	135093	129646	205389	274834	400865	265751	226545	246396	345609
21	284720	212009	149286	135211	131100	205898	274438	400991	265869	226570	245754	345814
22	284262	212065	149067	135116	131257	205935	274301	400729	265733	226536	246266	346321
23	284086	211803	149081	135469	131244	205951	274448	398509	265703	226566	246301	346205
24	284233	212222	149327	135396	131184	205841	274288	394171	264841	226613	245540	345553

	1	2	3	4	5	6	7	8	9	10	11	12
1	65237	79452	86112	92966	102480	102773	89859	76100	79977	94515	82982	61954
2	45068	57944	67701	77524	84197	75044	66094	56372	54587	64917	58343	45035
3	34433	42151	47196	55561	65768	58426	51083	43517	38536	42469	45677	35762
4	24687	28635	34941	46578	65142	60798	51330	40213	34481	33969	29015	26378
5	20542	28304	42256	72234	69168	52101	47850	49646	53763	51191	25664	22455
6	33649	41769	65880	53444	8013	197	3997	26368	65458	88112	44382	33341
7	75861	85750	36518	0	0	0	0	0	0	21972	76570	76280
8	58779	10581	0	0	0	0	0	0	0	0	404	38527
9	0	0	235	0	0	0	0	0	0	0	0	0
10	1753	0	0	0	0	0	0	0	0	0	5	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	133	0	0	0	0
13	0	0	0	0	0	0	0	2699	43	0	0	0
14	0	0	0	0	444	0	7147	4207	514	0	0	0
15	0	0	0	0	0	0	4011	9434	2156	0	0	0
16	0	0	0	0	0	0	3479	11487	4492	0	0	0
17	28769	175	0	0	0	0	4367	16288	7402	19655	30485	45515
18	35943	24439	13963	8197	0	1397	13255	46203	40912	29380	31896	44574
19	35487	27631	13662	11191	8580	24121	45852	66419	42720	27781	30629	45363
20	35746	24443	12810	11050	9435	26970	47261	63487	39639	27008	31194	45959
21	36103	23288	13348	13201	7491	26834	44222	60853	36479	29717	31721	46031
22	36458	25005	14325	11204	8788	21977	42439	60091	34520	27992	30978	46604
23	36430	24714	12764	11929	8727	24004	42620	59063	35135	27968	30206	49008
24	36969	26125	15087	12383	7564	23153	43434	51478	35661	26578	32727	45475

The month-hourly GHG emissions from gas generators and imports, and the calculated GHG emissions intensity for the SCE Preferred Portfolio, in 2030 are shown in the tables below.

Table F-4
PLEXOS Production Cost Simulation Month-Hourly GHG Emissions from Gas Generation in 2030 (tons of CO2e) – SCE Pathway System Plan

	1	2	3	4	5	6	7	8	9	10	11	12
1	116041	95176	78515	69931	68091	85824	106454	143763	104149	97035	99629	131501
2	115760	95357	77813	69731	68484	83862	103142	139911	101561	95142	98006	131165
3	114658	94376	76512	67716	66484	80230	100083	136985	99989	92572	96834	130374
4	113394	92609	75067	67196	66137	80011	100107	136211	99289	91507	95425	128252
5	112563	92515	75326	69127	65012	75558	97174	136904	100516	92834	94725	126859
6	114341	94287	76852	61357	45734	39290	67945	123909	95692	95919	96796	128231
7	118336	98336	62114	16077	14748	13355	16882	39088	35608	72196	96409	132455
8	110419	70308	20415	14196	14745	14294	16142	26184	13571	15483	45604	118852
9	38026	18241	12793	10393	11286	13545	15896	27684	12483	11903	15833	41017
10	32303	14605	11477	10393	11289	15770	18075	33156	12529	12119	15884	30183
11	21802	16167	11502	10393	11288	14740	16634	30573	12909	12115	13886	27849
12	21219	15477	11428	10385	11289	16337	21943	31591	12974	12090	14330	26878
13	21100	13577	11397	10393	11321	14185	34584	44210	13424	12102	14337	26683
14	21245	14644	11428	10393	11520	14558	38080	42764	13452	12140	13949	26788
15	21333	17322	11365	10393	11331	15103	22259	43013	12973	12284	14060	27541
16	23006	13776	11428	10368	11293	13682	25948	54269	21679	12808	15253	34395
17	86861	24091	11461	12541	11744	16092	45205	84392	57016	68499	76689	108856
18	95695	67360	47875	38495	21401	39087	78067	132611	87536	76237	82428	117043
19	96602	71448	51078	45912	42775	68372	93084	141024	90818	77241	83471	118049
20	96604	71767	51315	46657	45160	70398	94479	140919	91042	77217	83673	118054
21	96652	71830	51464	46678	45636	70578	94304	140968	91087	77227	83434	118104
22	96518	71852	51383	46648	45683	70590	94247	140853	91028	77212	83606	118279
23	96448	71750	51396	46776	45678	70600	94307	139848	91018	77218	83620	118261
24	96505	71913	51486	46749	45659	70571	94243	137940	90702	77238	83396	118029

Table F-5
PLEXOS Production Cost Simulation Month-Hourly GHG Emissions from CAISO Imports in 2030 (CO2e tons) – SCE Pathway System Plan

	1	2	3	4	5	6	7	8	9	10	11	12
1	27921	34006	36856	39789	43861	43987	38459	32571	34230	40453	35516	26516
2	19289	24800	28976	33180	36036	32119	28288	24127	23363	27784	24971	19275
3	14737	18041	20200	23780	28148	25006	21863	18625	16494	18177	19550	15306
4	10566	12256	14955	19935	27881	26022	21969	17211	14758	14539	12419	11290
5	8792	12114	18085	30916	29604	22299	20480	21248	23010	21910	10984	9611
6	14402	17877	28197	22874	3430	84	1711	11286	28016	37712	18995	14270
7	32469	36701	15630	0	0	0	0	0	0	9404	32772	32648
8	25158	4529	0	0	0	0	0	0	0	0	173	16490
9	0	0	101	0	0	0	0	0	0	0	0	0
10	750	0	0	0	0	0	0	0	0	0	2	0
11	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	57	0	0	0	0
13	0	0	0	0	0	0	0	1155	18	0	0	0
14	0	0	0	0	190	0	3059	1800	220	0	0	0
15	0	0	0	0	0	0	1717	4038	923	0	0	0
16	0	0	0	0	0	0	1489	4916	1923	0	0	0
17	12313	75	0	0	0	0	1869	6971	3168	8412	13047	19480
18	15384	10460	5976	3508	0	598	5673	19775	17510	12575	13652	19078
19	15189	11826	5847	4790	3672	10324	19625	28427	18284	11890	13109	19416
20	15299	10462	5483	4729	4038	11543	20228	27172	16965	11559	13351	19670
21	15452	9967	5713	5650	3206	11485	18927	26045	15613	12719	13577	19701
22	15604	10702	6131	4795	3761	9406	18164	25719	14775	11981	13259	19946
23	15592	10578	5463	5106	3735	10274	18241	25279	15038	11970	12928	20975
24	15823	11182	6457	5300	3237	9909	18590	22033	15263	11375	14007	19463

Table F-6
PLEXOS Production Cost Modeling Month-Hourly GHG Emission Intensity in 2030 (CO2e tons/MWh) – SCE Pathway System Plan

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.36	0.36	0.37	0.37	0.38	0.37	0.37	0.36	0.36	0.37	0.36	0.36
2	0.35	0.36	0.36	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36	0.35
3	0.35	0.35	0.36	0.36	0.37	0.36	0.36	0.36	0.35	0.35	0.35	0.35
4	0.35	0.35	0.35	0.36	0.37	0.36	0.36	0.36	0.35	0.35	0.35	0.35
5	0.35	0.35	0.36	0.37	0.37	0.36	0.35	0.36	0.36	0.36	0.35	0.35
6	0.35	0.35	0.36	0.36	0.35	0.35	0.34	0.35	0.36	0.37	0.35	0.35
7	0.36	0.36	0.36	0.44	0.47	0.45	0.43	0.36	0.35	0.35	0.36	0.36
8	0.36	0.35	0.42	0.48	0.49	0.44	0.44	0.41	0.45	0.44	0.35	0.35
9	0.35	0.38	0.46	0.51	0.51	0.44	0.43	0.40	0.45	0.46	0.40	0.35
10	0.37	0.41	0.49	0.51	0.51	0.42	0.40	0.39	0.45	0.45	0.40	0.38
11	0.40	0.39	0.49	0.51	0.51	0.45	0.42	0.40	0.44	0.45	0.43	0.39
12	0.40	0.40	0.49	0.51	0.51	0.42	0.38	0.40	0.44	0.45	0.42	0.40
13	0.41	0.44	0.49	0.51	0.51	0.43	0.38	0.38	0.43	0.45	0.42	0.40
14	0.40	0.41	0.49	0.51	0.49	0.43	0.39	0.38	0.43	0.45	0.43	0.40
15	0.40	0.38	0.49	0.51	0.50	0.42	0.40	0.38	0.44	0.45	0.43	0.40
16	0.39	0.44	0.48	0.51	0.50	0.43	0.38	0.37	0.38	0.43	0.41	0.36
17	0.35	0.36	0.46	0.46	0.48	0.41	0.35	0.35	0.34	0.35	0.35	0.35
18	0.35	0.35	0.35	0.36	0.39	0.35	0.35	0.36	0.35	0.35	0.35	0.35
19	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.36	0.35	0.35	0.35	0.35
20	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.36	0.35	0.35	0.35	0.35
21	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.36	0.35	0.35	0.35	0.35
22	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.35	0.35	0.35	0.35
23	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.35	0.35	0.35	0.35
24	0.35	0.35	0.35	0.35	0.35	0.35	0.36	0.36	0.35	0.35	0.35	0.35

NOx Calculation Methodology

SCE applied a similar methodology to calculate NOx emissions, including NOx emissions from steady state operations, as well as emissions resulting from unit starts and stops. The steps to calculate the NOx emission intensity are summarized below.

First, the hourly steady state NOx emissions by month were calculated based on the hourly gas generation (in MW) from the PLEXOS production cost simulation modeling results and the Commission's NOx emission rates (pounds/MWh). The Commission's NOx and PM2.5 emission rates are shown in Table F-7 below.

Table F-7
Commission-estimated NOx and PM2.5 Emission Rates

E3 Type	NOx lb/MWh	PM2.5 lb/MMBtu	Class
BANC_CCGT	0.07	0.0066	CCGT
BANC_Peaker	0.099	0.0066	Peaker
CAISO_Advanced_CCGT	0.07	0.0066	CCGT
CAISO_Aero_CT	0.099	0.0066	Peaker
CAISO_CCGT1	0.07	0.0066	CCGT
CAISO_CCGT2	0.07	0.0066	CCGT
CAISO_CHP	0	0	CHP
CAISO_Peaker1	0.099	0.0066	Peaker
CAISO_Peaker2	0.279	0.0066	Peaker
CAISO_Reciprocating_Engine	0.5	0.01	IC Engine
CAISO_ST	0.15	0.0075	Steam Turbine
IID_CCGT	0.07	0.0066	CCGT
IID_Peaker	0.099	0.0066	Peaker
LDWP_CCGT	0.07	0.0066	CCGT
LDWP_Peaker	0.099	0.0066	Peaker

Second, in order to calculate the hourly NOx emissions from starts and stops, the annual total number of gas generator starts and stops by category were estimated based on the PLEXOS production cost modeling results. The annual total number of generator starts by category for the SCE Pathway System Plan are shown below.[5]

Table F-8
Number of Generator Starts and Shutdowns in 2030 for SCE Pathway System Plan from PLEXOS Production Cost Simulation

	CCGT	CHP	Peaker
Cold Start	460	12	81
Warm Start	5,807	653	1,170
Shutdown	6,267	665	1,251

The annual NOx emissions from starts and stops for combined cycle gas turbine ("CCGT") and CHP plants were calculated using the average emissions factors obtained from

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[5]   SCE used the SCE Pathway System Plan results for the SCE Preferred Portfolio and Reference System Plan results for the SCE Conforming Portfolio.

external sources.[6] The annual NOx emissions from starts and stops for peaker plants were calculated using the NOx start and stop emissions limit on SCE's peaker plant permits. The annual NOx emissions from starts and stops were distributed to the hourly level by each month proportional to the hourly gas generation obtained from the PLEXOS production cost modeling results.

Finally, the hourly NOx emission intensity by month was calculated by dividing the hourly total NOx emissions by the weighted average hourly gas generation. The hourly NOx emissions intensity (pounds of NOx/MWh) by month for the SCE Pathway System Plan in 2030 is shown in Table F-9 below.[7]

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[6] *See* Robert J. Bivens, *Startup and Shutdown NOx Emissions from Combined-Cycle Combustion Turbine Units*, May 24, 2002, available at: http://www.rmb-consulting.com/papers/SUSD%20Chicago%20Paper.pdf; D. Lew et. al., *Impacts of Wind and Solar on Fossil-Fueled Generators*, August 2012, available at: https://www.nrel.gov/docs/fy12osti/53504.pdf.

[7] SCE used the SCE Pathway System Plan results for the SCE Preferred Portfolio and Reference System Plan results for the SCE Conforming Portfolio.

Table F-9
PLEXOS Production Cost Simulation Month-Hourly NOx Emission Intensity in 2030 (pounds of NOx/MWh) – SCE Pathway System Plan

	1	2	3	4	5	6	7	8	9	10	11	12
1	0.1002	0.1089	0.1160	0.1227	0.1247	0.1196	0.1195	0.1029	0.1115	0.1122	0.1067	0.0950
2	0.1002	0.1089	0.1159	0.1226	0.1245	0.1194	0.1194	0.1028	0.1114	0.1121	0.1067	0.0949
3	0.1002	0.1088	0.1159	0.1226	0.1244	0.1194	0.1194	0.1027	0.1114	0.1121	0.1067	0.0949
4	0.1002	0.1088	0.1158	0.1226	0.1244	0.1194	0.1194	0.1027	0.1114	0.1121	0.1067	0.0949
5	0.1002	0.1088	0.1158	0.1226	0.1245	0.1195	0.1194	0.1027	0.1114	0.1121	0.1067	0.0949
6	0.1002	0.1088	0.1159	0.1227	0.1241	0.1191	0.1193	0.1028	0.1115	0.1121	0.1067	0.0949
7	0.1002	0.1089	0.1157	0.1236	0.1232	0.1230	0.1238	0.1044	0.1123	0.1121	0.1067	0.0949
8	0.1003	0.1088	0.1175	0.1218	0.1219	0.1204	0.1242	0.1068	0.1177	0.1174	0.1073	0.0950
9	0.1016	0.1125	0.1180	0.1227	0.1222	0.1207	0.1243	0.1066	0.1183	0.1193	0.1122	0.0961
10	0.1022	0.1144	0.1190	0.1227	0.1222	0.1200	0.1227	0.1056	0.1183	0.1193	0.1122	0.0974
11	0.1043	0.1133	0.1189	0.1227	0.1222	0.1202	0.1233	0.1061	0.1174	0.1188	0.1139	0.0979
12	0.1046	0.1137	0.1190	0.1227	0.1222	0.1197	0.1216	0.1059	0.1173	0.1190	0.1134	0.0981
13	0.1046	0.1156	0.1190	0.1227	0.1222	0.1199	0.1212	0.1046	0.1160	0.1189	0.1134	0.0982
14	0.1045	0.1144	0.1190	0.1227	0.1225	0.1198	0.1207	0.1049	0.1173	0.1188	0.1139	0.0981
15	0.1045	0.1128	0.1191	0.1227	0.1223	0.1198	0.1221	0.1050	0.1178	0.1191	0.1136	0.0979
16	0.1038	0.1151	0.1191	0.1227	0.1229	0.1221	0.1213	0.1040	0.1147	0.1197	0.1127	0.0967
17	0.1004	0.1111	0.1222	0.1242	0.1238	0.1215	0.1196	0.1029	0.1114	0.1120	0.1067	0.0951
18	0.1003	0.1088	0.1158	0.1212	0.1224	0.1191	0.1191	0.1030	0.1113	0.1119	0.1066	0.0950
19	0.1002	0.1087	0.1159	0.1222	0.1239	0.1188	0.1192	0.1029	0.1112	0.1118	0.1065	0.0950
20	0.1002	0.1087	0.1159	0.1221	0.1237	0.1188	0.1191	0.1029	0.1112	0.1118	0.1065	0.0950
21	0.1002	0.1087	0.1159	0.1221	0.1237	0.1187	0.1191	0.1029	0.1112	0.1118	0.1066	0.0950
22	0.1003	0.1087	0.1159	0.1221	0.1236	0.1187	0.1191	0.1029	0.1112	0.1118	0.1065	0.0950
23	0.1002	0.1087	0.1159	0.1221	0.1236	0.1187	0.1191	0.1029	0.1112	0.1118	0.1065	0.0950
24	0.1003	0.1087	0.1159	0.1221	0.1237	0.1187	0.1191	0.1028	0.1112	0.1118	0.1066	0.0950

PM2.5 calculation methodology

Given that PM2.5 emissions are primarily dependent upon fuel consumption, an hourly PM2.5 emissions intensity was calculated by dividing the hourly PM2.5 emissions by the hourly gas generation from the PLEXOS production cost simulation modeling results. The hourly PM2.5 emissions were calculated using the Commission's emission rate as shown in Table F-7 and the hourly fuel burn from the PLEXOS production cost simulation modeling results. The hourly PM 2.5 emissions intensity by month for the SCE Pathway System Plan in 2030 is shown in Table F-10 below.[8]

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[8]   SCE used the SCE Pathway System Plan results for the SCE Preferred Portfolio and Reference System Plan results for the SCE Conforming Portfolio.

Table F-10
Plexos Production Cost Simulation Month-Hourly Emission Intensity in 2030 (pounds of PM2.5/MWh) – SCE Pathway System Plan

|	1	2	3	4	5	6	7	8	9	10	11	12
1	0.0432	0.0436	0.0439	0.0444	0.0448	0.0442	0.0439	0.0443	0.0439	0.0439	0.0435	0.0434
2	0.0431	0.0433	0.0437	0.0442	0.0446	0.0440	0.0436	0.0440	0.0436	0.0436	0.0432	0.0433
3	0.0431	0.0432	0.0436	0.0440	0.0443	0.0437	0.0434	0.0439	0.0434	0.0434	0.0431	0.0432
4	0.0430	0.0431	0.0435	0.0439	0.0444	0.0438	0.0434	0.0438	0.0434	0.0433	0.0431	0.0431
5	0.0430	0.0431	0.0435	0.0441	0.0444	0.0436	0.0434	0.0439	0.0435	0.0434	0.0430	0.0431
6	0.0431	0.0432	0.0438	0.0441	0.0451	0.0450	0.0436	0.0438	0.0436	0.0438	0.0432	0.0432
7	0.0433	0.0437	0.0442	0.0578	0.0614	0.0614	0.0580	0.0472	0.0457	0.0436	0.0435	0.0435
8	0.0432	0.0434	0.0555	0.0619	0.0615	0.0578	0.0599	0.0540	0.0619	0.0597	0.0446	0.0432
9	0.0459	0.0513	0.0604	0.0657	0.0647	0.0579	0.0594	0.0534	0.0629	0.0641	0.0552	0.0459
10	0.0479	0.0565	0.0643	0.0657	0.0647	0.0560	0.0541	0.0515	0.0631	0.0626	0.0551	0.0501
11	0.0537	0.0530	0.0642	0.0657	0.0647	0.0585	0.0575	0.0532	0.0608	0.0626	0.0604	0.0521
12	0.0545	0.0543	0.0645	0.0658	0.0647	0.0551	0.0507	0.0522	0.0605	0.0628	0.0585	0.0531
13	0.0547	0.0612	0.0648	0.0657	0.0648	0.0566	0.0497	0.0486	0.0591	0.0628	0.0585	0.0534
14	0.0544	0.0563	0.0645	0.0657	0.0639	0.0558	0.0495	0.0490	0.0593	0.0625	0.0605	0.0533
15	0.0543	0.0516	0.0651	0.0657	0.0644	0.0552	0.0532	0.0492	0.0611	0.0620	0.0600	0.0524
16	0.0522	0.0602	0.0645	0.0660	0.0646	0.0584	0.0499	0.0464	0.0503	0.0604	0.0566	0.0477
17	0.0431	0.0476	0.0641	0.0598	0.0629	0.0544	0.0450	0.0442	0.0437	0.0435	0.0432	0.0431
18	0.0430	0.0431	0.0445	0.0450	0.0501	0.0454	0.0436	0.0442	0.0434	0.0434	0.0431	0.0432
19	0.0430	0.0431	0.0444	0.0446	0.0452	0.0437	0.0436	0.0443	0.0434	0.0434	0.0431	0.0432
20	0.0430	0.0431	0.0444	0.0446	0.0451	0.0437	0.0436	0.0443	0.0435	0.0434	0.0431	0.0432
21	0.0430	0.0431	0.0444	0.0445	0.0450	0.0437	0.0436	0.0443	0.0435	0.0434	0.0431	0.0432
22	0.0430	0.0431	0.0444	0.0446	0.0450	0.0437	0.0436	0.0443	0.0434	0.0434	0.0431	0.0432
23	0.0430	0.0431	0.0444	0.0446	0.0450	0.0437	0.0436	0.0442	0.0434	0.0434	0.0431	0.0432
24	0.0430	0.0431	0.0444	0.0446	0.0450	0.0437	0.0436	0.0441	0.0434	0.0434	0.0432	0.0432

Appendix G.1

CNS Calculator (GHG) – SCE Preferred Portfolio

**SEE NOTICE OF AVAILABILITY FOR
PUBLIC VERSION OF APPENDIX G.1**

Appendix G.2

CNS Calculator (NOx) – SCE Preferred Portfolio

SEE NOTICE OF AVAILABILITY FOR
PUBLIC VERSION OF APPENDIX G.2

Appendix G.3

CNS Calculator (PM2.5) – SCE Preferred Portfolio

SEE NOTICE OF AVAILABILITY FOR
PUBLIC VERSION OF APPENDIX G.3

Appendix H

Demographics of DAC-Designated Census Tracts, Aggregated to County Subdivision, in SCE's Service Area

Introduction

This Appendix contains demographic information on the DACs located within SCE's distribution service area. The document includes references to California averages regarding age, income, and educational attainment. These averages are as follows.

- Median age: 36 years

- Per capita income: $31,458

- Household income: $63,783

- High school diploma attainment: 82.1%

- Bachelor's degree or higher attainment: 32%

Demographic data in this Appendix is sourced from the Knight Foundation's *Census Reporter* tool.[1] SCE used the CEC's ArcGIS open source mapping tool to determine power plant locations.[2]

Anaheim-Santa Ana-Garden Grove

There are 46 DAC-designated census tracts in this subdivision, comprising 266,529 people out of a total population of 1,583,930 – 17% of the population. DACs in this subdivision are primarily clustered in the western half of the subdivision and the most highly-impacted DACs are near transit corridors. The population of the subdivision is slightly younger (median of 34.7 years), and has a slightly lower per person income, but slightly higher household income when compared to the state average. The largest ethnic group is Hispanic (48%), followed by White (29%), and Asian (19%). 36% of adults speak Spanish in the home. Educational attainment is slightly less than the California average for both high school graduation and bachelor's degree attainment. The AES Huntington Beach power plant is located in the subdivision, but not in a DAC. Barre Peaker is located in Stanton, also a DAC. SCE regularly

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[1] *See Census Reporter*, available at: https://censusreporter.org/.
[2] *See* CEC, *California Operational Power Plant*, updated February 1 2018, available at: http://caenergy.maps.arcgis.com/apps/webappviewer/index.html?id=ad8323410d9b47c1b1a9f751d62fe495.

engages with the DAC-designated communities in this subdivision, including through a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Reverend Frank Jackson, Village Solutions Foundation).

Arvin-Lamont

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there is one DAC-designated census tract in SCE's service area in this subdivision, comprising 6,158 people out of a total population of 43,227 – 14% of the population. Most of the rural subdivision falls in PG&E's service area and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to SCE's service area. The population of the subdivision is younger (median of 25.7 years), and has a significantly lower per-person income and lower household income compared to the state average. 32% of the population is below poverty level. The largest ethnic group is Hispanic (92%). 84% of the population speaks Spanish in the home. Educational attainment is only half of the California average for high school graduation. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Bakersfield

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there is one DAC-designated census tract in SCE's service area in this subdivision, comprising 6,158 people out of a total population of 411,089 – 1.5% of the population. Most of the subdivision falls in PG&E's service area and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to SCE's service area. The population of the subdivision is slightly younger (median of 30.3 years), and has a lower per-person income and lower household income when compared to the state average – two-thirds of the state average. 24% percent of the population is below poverty level. The largest ethnic groups are Hispanic (53%) followed by White (34%). Just under 50% of the population speaks Spanish in the home. Educational attainment is less than the California average for high school graduation. There are several fossil fuel power plants in the subdivision,

but all appear to be outside SCE's service area. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Barstow

There are six DAC-designated census tracts in this subdivision, comprising 29,323 people out of a total population of 61,998 – 47% of the population. The DACs are clustered around the city of Barstow. The population of the subdivision is slightly younger (median of 34.7 years), and has a lower per person income and lower household income when compared to the state average. 30% of the population is below poverty level. The largest ethnic groups are Hispanic (41%) and White (41%), followed by African American (10%). 79% of the population speaks English only in the home. Educational attainment is slightly less than the California average for high school graduation and significantly less for bachelor's degree or higher attainment. SCE engages with the DAC-designated communities through its Local Public Affairs staff and relationships with the Mojave Valley United Way, the Barstow Senior Center, and the Barstow College Foundation.

Blythe

There is only one DAC census tract in this San Bernardino County subdivision, comprising 3,341 people out of a total population of 15,045 – 22% of the population. The DAC is in the southern half of city of Blythe, along the I-10 freeway. Because this is a singular DAC surrounded by a large rural non-DAC area, the demographics included reflect the DAC rather than the subdivision. This census tract contains 17% children under 10 compared to the average in California census tracts of 13%. It also contains 11% elderly over 65 compared to the average in California census tracts of 12%. 60% of people in this census tract are living below twice the federal poverty level. The largest ethnic groups are Hispanic (64%) and White (19%), followed by African American (14%). Educational attainment is less than the California average for high school – 33% of adults in this census tract have less than a high school education. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Camarillo

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there is one DAC-designated census tract in this subdivision, comprising 5,091 people out of a total population of 69,937 – 7% of the population. Most of the subdivision's census tracts are not rated as DACs and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to DAC-designated areas. This Ventura County subdivision is adjacent to the Oxnard subdivision, which has a significantly higher concentration of DACs. The population of the subdivision is slightly older (median of 38.2 years), and has a higher per person income and higher household income when compared to the state average – about 20% higher than the state average. 6% of the population is below poverty level. The largest ethnic groups are White (59%) followed by Hispanic (26%). Educational attainment is higher than the California average for both high school graduation and college. There are two fossil fuel power plants in the subdivision. SCE engages with the DAC-designated communities through its Local Public Affairs staff and a member of our Consumer Advisory Panel, Bernardo Perez, who is a Trustee of the Ventura County Community College District.

Central Coast

There are three DAC-designated census tracts in this subdivision, comprising 12,644 people out of a total population of 304,042 – 4% of the population. The majority of the subdivision's census tracts are not rated as DACs, and the three census tracts that are designated as DACs are in industrialized and commercial areas. The population of the subdivision is on par with the state's median age (35.8 years), and has a higher per person income and higher household income when compared to the state average. 14% of the population is below poverty level. The largest ethnic groups are White (60%) followed by Hispanic (21%). Educational attainment is higher than the California average for both high school graduation and college. There are two fossil fuel power plants in the subdivision – one at John Wayne Airport and one at UC Irvine, neither of which are in DAC census tracts. SCE engages with the DAC-designated

communities in this region through its Local Public Affairs staff and members of our Consumer Advisory Panel (Charles Dorsey of the National Diversity Coalition and Reverend Frank Jackson Jr., Chairman/CEO of Village Solutions Foundation).

Corcoran

There is one DAC-designated census tract in this Kings County subdivision, comprising 3,591 people out of a total population of 14,717 – 24% of the population. Most of the subdivision falls in PG&E's service area and the region is largely agricultural. The population of the subdivision is younger (median of 29.4 years), and has a significantly lower per person income and lower household income when compared to the state average – almost one-half of the state average. 36% of the population is below poverty level. The largest ethnic groups are Hispanic (81%) followed by White (15%). About 50% of the population speaks Spanish in the home. Educational attainment is less than the California average for high school graduation and only 5% of the population has a bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Compton

There are 78 DAC-designated census tracts in this subdivision, comprising 378,388 people out of a total population of 421,148 – 90% of the population. This is one of the most impacted subdivision areas. The subdivision runs along the heavily congested I-710 corridor, transporting goods to and from the Port of Long Beach. The population of the subdivision is slightly younger (median of 32.3 years), and a per person income that is approximately one-half of the state average. Household income also lags state averages, but not with such extreme disparity. The largest ethnic group is Hispanic (62%), followed by Black (22%) and Asian (9%). 53% of adults speak Spanish in the home. Educational attainment is lower than the California average for both high school graduation and bachelor's degrees. There are two gas-powered plants in the subdivision (Carson Cogeneration, Watson Cogeneration) and a gas digester (Total Energy). SCE regularly engages with the DAC-designated communities in this subdivision, including through representatives on its Clean Energy Access Working Group and environmental

justice stakeholders (EarthJustice, Right to Zero, East Yard Communities). SCE also liaises with these entities regularly on transportation electrification issues.

Corona

There are 10 DAC-designated census tracts in this subdivision, comprising 54,711 people out of a total population of 221,181 – 25% of the population. The most heavily impacted census tracts in the subdivision are along the 91 Freeway. The population of the subdivision is slightly younger (median of 34.5 years). Per person income is slightly less than the state average, but household income exceeds the state average. 12% of the population is below the poverty line. However, the subdivision also includes some areas that are non-DAC and fairly affluent, so this data may not be DAC-representative. The largest ethnic group is Hispanic (44%), followed by White (37%) and Asian (11%). Educational attainment is on par with the California average for high school graduation and slightly lagging in bachelor's degree attainment. There are two gas-powered plants in the subdivision (Corona Cogeneration, Clear Water Cogeneration). SCE engages with this community through a variety of community and civic engagements led by SCE's Local Public Affairs staff (Soroptomist International of Corona) and our corporate philanthropy efforts (YMCA, United Way).

Death Valley

There is one DAC-designated census tract in this subdivision, which comprises nearly the entire Inyo County subdivision, with a population of 492. The population of the subdivision is older (median of 49.3 years), and has a lower per person income and lower household income when compared to the state average. 26% of the population is below poverty level. The largest ethnic groups are White (79%) followed by Hispanic (8%). Educational attainment is higher than the California average for high school graduation but lower for attainment of a bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Delano-McFarland

There are five DAC-designated census tracts in this subdivision, comprising 38,469 people out of a total population of 65,287 – 59% of the population. The most heavily impacted DACs are in the rural agricultural areas, outside of the more densely populated cities of McFarland and Delano. The population of the subdivision is younger (median of 28.7 years). Per person income is less than one-third the state average and household income is one-half the state average. 30% of the population are below the poverty line, nearly double the rate of the state. The largest ethnic group is Hispanic (80%) followed by Asian (9%). Educational attainment is significantly less that the California average for both high school graduation and bachelor's degree attainment. SCE regularly engages with the DAC-designated communities in this subdivision, including through a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization).

Downey-Norwalk

There are 67 DAC-designated census tracts in this subdivision, comprising 331,960 people out of a total population of 556,859 – 60% of the population. The most heavily impacted DACs are along the transportation corridors of the I-710, I-605, and I-5. The population of the subdivision is on par with the state average in age (median of 35.1 years), has a per person income that is less than the state average, and a household income that is slightly less than the state average. The largest ethnic group is Hispanic (62%) followed by Asian (17%). Educational attainment is less that the California average for high school graduation and only at two-thirds of the average for bachelor's degree attainment. There are four gas-powered generators in the subdivision (Center Peaker, Technicast, Norwalk Energy, and O'Brien). SCE regularly engages with the DAC-designated communities in this subdivision, including through its Local Public Affairs representative, its work with environmental justice organizations such as East Yard Communities, and its corporate philanthropic engagement in the area,

including with the Los Angeles County Public Library Foundation for Science Technology Engineering Art Math education programs.

Dinuba

An ArcGIS analysis of DAC census tracts and SCE's service area indicate that there are two DAC-designated census tracts in SCE's service area in this Tulare County subdivision, comprising 14,371 people out of a total population of 34,699 – 40% of the population. Most of the subdivision falls in PG&E's service area and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues, but we have decided to include it because of the proximity. Relative to the state average, the population of the subdivision is younger (median of 28.6 years), has a lower per person income of about one-half, and also a comparatively lower household income. 29% of the population is below poverty level. The largest ethnic groups are Hispanic (81%) followed by White (15%). Just under 50% of the population speaks Spanish in the home. Educational attainment is less than the California average for high school graduation and for bachelor's degree attainment. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

East Kern County

There is one DAC-designated census tract in this subdivision, comprising 5,152 people out of a total population of 105,614 – 5% of the population. The DAC surrounds, but does not include the census tracts of California City. The population of the subdivision is on par in age (median of 35.1 years), and has a lower per person income and lower household income when compared to the state average. 20% of the population is below poverty level. The largest ethnic groups are White (56%) followed by Hispanic (25%). Educational attainment is higher than the California average for high school graduation but lower for attainment of a bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Earlimart

There are six DAC-designated census tracts in this subdivision, comprising 51,714 people out of a total population of 78,293 – 66% of the population. The subdivision is a rural agricultural area and along the CA-99 transportation corridor. The population of the subdivision is significantly younger (median of 24.9 years), has a per person income that is less than one-third the state average, and a household income two-fifths of the state average. Almost 50% of the population is below the poverty line. The largest ethnic group is Hispanic (88%), followed by Asian (6%). Educational attainment is significantly less than the California average for both high school graduation (one-third of the population) and bachelor's degree attainment (2% of the population). SCE regularly engages with the DAC-designated communities in this subdivision, including through a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization).

East San Gabriel Valley

There are 78 DAC-designated census tracts in this subdivision, comprising 378,761 people out of a total population of 1,062,696 – 36% of the population. The most heavily impacted DACs are along the transportation corridor of the I-605 freeway, and where it intersects with I-210, I-10, and CA-60. This area is heavily industrialized. The subdivision's population is on par with the state average in age (median of 36 years), and has a per person income that is less than the state average, but a household income slightly above the state average. The largest ethnic group is Hispanic (55%) followed by Asian (21%). Educational attainment is slightly less that the California average for high school graduation and less than the average for bachelor's degree attainment. There are three gas-powered generators in the subdivision (Walnut Creek, Pacific Palms Cogen, Simpson) and two bio-gas (Minnesota Methane, Spadra Landfill, Puente Hills Recovery). SCE regularly engages with the DAC-designated communities in this subdivision, including through its Community Advisory Panel representative members (Thomas Wong, Climate Resolve; San Gabriel Valley Municipal Water District).

Elsinore Valley

There are six DAC-designated census tracts in this subdivision, comprising 41,304 people out of a total population of 224,683 – 18% of the population. Because most of the subdivision is not in a DAC area, the following information refers to the two DAC areas which are located in the community of Lake Elsinore. The DACs combined population is 9,500. The population is significantly younger (median of 23.5 years), and has a per person income and household income that is less than the state average. The largest ethnic group is Hispanic (60%) followed by White (30%). Educational attainment is significantly less that the California average for both high school graduation and bachelor's degree attainment. SCE regularly engages with the DAC-designated communities in this subdivision through its Local Public Affairs staff.

Exeter

There are two DAC-designated census tracts in this subdivision, comprising 11,332 people out of a total population of 61,510 – 18% of the population. The DACs represent the agricultural areas of Farmersville and surrounding area with a combined population of about 11,332. The population of these DACs is younger than the state average and average income is significantly less than the state average, with about 30% of the population below the poverty line. The largest ethnic group is Hispanic (80%). Educational attainment is significantly less that the California average for both high school graduation and bachelor's degree attainment. SCE engages with the DAC-designated communities in this subdivision through its Local Public Affairs staff.

Hanford

There are eight DAC-designated census tracts in this subdivision, comprising 41,331 people out of a total population of 84,928 – 49% of the population. Many of the DACs are located in the central and southern portions of the City of Hanford, which is in SCE's service area. For at least one large rural DAC located to the south of the city, that tract is in PG&E's service area. The median age of the subdivision (32 years) is less than the state median (36).

The per person income is only two-thirds of the state average; although the household income is somewhat higher, it is still 20% below the state average. Approximately 20% of the subdivision lives below the poverty line, which is 25% higher than the state average. The largest ethnic group is Hispanic (50%) followed by White (39%). 30% of the population speaks Spanish at home, which is the state average. Educational attainment is only slightly below average for high school graduation, but bachelor's degree attainment is only one-half the state average. SCE engages with the DAC-designated communities in this subdivision through its Local Public Affairs staff, via a representative on its Consumer Advisory Panel and Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization), and through its corporate philanthropy (College of the Sequoias - Hanford Campus, Kings Art Center, Kings Community Action Organization, Self Help Enterprises, United Way).

Hanford Northeast

There is one DAC-designated census tract in this subdivision, comprising the entire population of 3,457 people, with only one-half of the DAC being in SCE's service area. The population is older (median of 40.9 years), and has a higher per person income and household income when compared to the state average. 15% of the population is below poverty level. The largest ethnic groups are White (60%) followed by Hispanic (34%). Educational attainment is slightly lower than the California average for high school graduation and for attainment of a bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff, via a representative on its Consumer Advisory Panel and Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization), and through its corporate philanthropy (College of the Sequoias - Hanford Campus, Kings Art Center, Kings Community Action Organization, Self Help Enterprises, United Way).

Hemet-San Jacinto

There are four DAC-designated census tracts in this subdivision, comprising 23,523 people out of a total population of 189,700 – 12% of the population. These DACs include the

downtown and northwest sections of the City of Hemet. The median age of the subdivision is roughly the same as the state (36 years). Both per person and median household income are 60% of the state average. Approximately 22% of the subdivision lives below the poverty line, which is 40% higher than the state average. The largest ethnic groups are Hispanic and White, both at 43%. 30% of the population speaks Spanish at home, which is the state average. Educational attainment is only slightly lower than average for high school graduation, but bachelor's degree attainment is only 40% the state average. SCE engages with the DAC-designated communities in this subdivision through its Local Public Affairs staff, via a representative on its Clean Energy Access Working Group (Grid Alternatives – Inland Empire), and through its corporate philanthropy (St. Carries Center for Human Development, Valley Resources Center for the Retarded, United Way).

Inglewood

There are 57 DAC-designated census tracts in this subdivision, comprising 269,449 people out of a total population of 406,217 – 66% percent of the population. Many customers live in DACs, the worst of which lie along the west side of the I-710 corridor, which transports goods to and from the Port of Long Beach. The median age of the subdivision (34 years) is less than the state median. Both per person and median household income are two-thirds of the state average. Approximately 20% of the subdivision lives below the poverty line, which is a substantially higher share than the state average. The largest ethnic group is Hispanic (53%), followed by Black (28%), Asian (8%), and White (8%). Educational attainment is less than average for high school graduation; bachelor's degree attainment is 60% of the state average. SCE engages with the DAC-designated communities in this subdivision in many ways, including through its Local Public Affairs staff, through a representative on its Consumer Advisory Panel (Reverend Frank Jackson Jr., Village Solutions Foundation), several representatives on its Clean Energy Access Working Group (Village Solutions Foundation, Business Resource Group, Grid Alternatives), and through its corporate philanthropy (including El Camino Community College, Grid Alternatives, I Have a Dream Foundation, Infinite Learning, Our Community Works,

Social Justice Learning Institute, South Bay Workforce Investment Board, Urban Scholars Academy).

Irvine-Lake Forest

There is one DAC-designated census tract in this Orange County subdivision, comprising 549 people out of a total population of 324,286. It is designated a high-pollution, low-population tract. This is the site of the former El Toro Marine Base and now the Orange County Great Park. SCE engages with the stakeholders and management of the Great Park via engagement with Irvine city officials.

Ivanhoe

There is one DAC-designated census tract in this subdivision, comprising the entire Tulare County subdivision and its 6,200 residents. The population is slightly younger (median of 33.8 years), and has a per-person income and household income that is one-half of the state average. 35% of the population is below poverty level. The largest ethnic groups are Hispanic (68%) followed by White (31%). Educational attainment is lower than the California average for high school graduation and for attainment of a bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Jurupa

There are 17 DAC-designated census tracts in this subdivision, comprising 86,626 people out of a total population of 173,200 – 50% of the population. The DACs are located primarily along the CA-60 freeway. The population of the subdivision is younger (median of 32 years) than for the county and the state, and the per person income level is lower than for the county and the state. The largest ethnic group is Hispanic (58%), followed by White (22%) and Asian (12%). Educational attainment is lower than the county and state levels; bachelor's degree attainment is three-fifths the state level. There are two power plants in the area, comprised of two gas units owned by the city of Riverside, and SCE's Mira Loma peaker gas plant just on the western edge of the area. SCE regularly engages with the DAC-designated communities in the

Jurupa subdivision through its two Clean Energy Access Working Group representatives in the Riverside area (Bambi Tran and Lisa Castilone of Grid Alternatives Inland Empire).

Lake Arrowhead

There are three DAC-designated census tracts in this subdivision, comprising 18,862 people. The DAC census tracts are located along the transportation corridors of I-215 and I-15. The population of the subdivision is older (median of 42 years), and has a slightly lower per person income and household income when compared to the state average. 17% of the population is below poverty level. The largest ethnic groups are White (73%) followed by Hispanic (20%). Educational attainment is slightly higher than the California average for high school graduation, but is below the state average for attainment of bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Lake Isabella

There are two DAC-designated census tracts in this Kern County subdivision, comprising 11,310 people out of a total population of 29,262 – 39% of the population. The population of the subdivision is significantly older (median of 56.7 years), and has a lower per person income and household income when compared to the state average. 22% of the population is below poverty level. The largest ethnic groups are White (86%) followed by Hispanic (10%). Educational attainment is slightly higher than the California average for high school graduation, but is below the state average for attainment of bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Lake Mathews

There are eight DAC-designated census tracts in this subdivision, comprising a total population of 27,628. The median population of the subdivision is a little younger (35 years), and has a slightly lower per person income, but a higher household income when compared to the state average. 18% of the population is below poverty level. The largest ethnic groups are Hispanic (52%) followed by White (36%). Educational attainment is slightly lower than the California average for high school graduation, and also below state average for attainment of

bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Lindsay

There are two DAC-designated census tracts in this subdivision, comprising 11,232 people out of a total population of 30,404 – 37% of the population. The DACs seem to be dispersed throughout the subdivision. The population of the subdivision (median of 30.5 years) is about the same as for the county, but younger than the state average. The per person and household income levels are significantly lower compared to both the county and the state. For example, the per person income level is about two-fifths of the state income level. The largest ethnic group is Hispanic (83%) followed by White (14%). Educational attainment is far below the county and state levels; bachelor's degree attainment (at 6.9%) is one-fifth the state level. The poverty level is 25% higher than for the county and double the state's level. SCE regularly engages with the DAC-designated communities in the Lindsay subdivision through its Local Public Affairs staff. Representation is also through the Consumer Advisory Panel's Courtney Kalashian of the San Joaquin Valley Clean Energy Organization, who also represents the area as a member of the Clean Energy Access Working Group.

Lemoore

There is one DAC-designated census tract in this Kings County subdivision, comprising 5,476 people out of a total population of 36,599 – 14% of the population, located near the town of Armona. The majority of the subdivision, including the town of Lemoore, is in PG&E's service area. The population of the subdivision is a younger (median of 26.5 years) and has a slightly lower per person income and household income when compared to the state average. 16% of the population is below poverty level. The largest ethnic groups are White (43%) followed by Hispanic (38%). Educational attainment is about the same as the California average for high school graduation, and below for attainment of bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Long Beach-Lakewood

There are 69 DAC-designated census tracts in this subdivision, comprising 313,211 people out of a total population of 656,558 – 48% of the population. The DACs are located primarily along Pacific Coast Highway and the I-710 freeway, the latter being a major transportation corridor continually traversed by freight trucks and other vehicles. The population of the subdivision is slightly younger (median of 34.7 years), and the per person income/household income levels are a bit lower than the county and state levels. Its poverty rate is a little higher than the county rate, and 20% higher than the state poverty rate. The largest ethnic group is Hispanic (42%), followed by White (21%) and Asian (14%). 40% of children, and 31% of adults, speak Spanish in the home. Educational attainment is about the same as the county and state levels; however, bachelor's degree attainment is lower than for the county and the state. Several gas power plants are situated nearby the I-710 transit corridor: owners of these plant include plants Harbor Cogeneration Company, LADWP, Air Products and Chemicals Inc., Watson Cogeneration Company, Andeavor (formerly Tesoro), and Eco Services Operations Corp. All of these gas plants are within the DAC area. SCE regularly engages with the DAC-designated communities in the Long Beach-Lakewood subdivision through its Consumer Advisory Panel representative (Mariko Kahn of Pacific Asian Counseling Services). Additionally, the Clean Energy Access Working Group representative for the area is Patricia Watts of the American Association of Blacks in Energy and the California Public Utilities Commission Low Income Oversight Board.

Los Angeles

There are 55 DAC-designated census tracts in this subdivision, comprising 227,634 people out of a total population of 496,618 – 46% of the population. The median age of the subdivision (34.6 years) is slightly lower than the state. Household income is about three-quarters of the California average, and per capita is about the same. The largest ethnic group is Hispanic (48%), followed by White (26%), Asian (12%), and Black (12%). 43% of adults speak English only in the home, and 40% speak Spanish only. Educational level is about the same as

the state for high school graduation levels, and bachelor degree attainment is slightly higher than the state rate. There are several gas-powered plants in the subdivision, but they fall outside of SCE's service area. SCE engages with the DAC-designated communities through its Local Public Affairs staff in the area.

Newberry Springs-Baker

There is one DAC-designated census tract in this subdivision, comprising 3,846 people out of a total population of 42,538 – 9% of the population. The median age of the subdivision (23.3 years) is much younger than the state. Per person income is 60% of the state average, with median household income at 80% of the state average. The poverty rate is 20% less than the state average. The largest ethnic group is White (51%) followed by Hispanic (24%). Educational attainment is 10% higher than the state average for high school graduation; bachelor's degree attainment is 20% less than of the state average. SCE engages with the DAC-designated communities in this subdivision through its Local Public Affairs staff, via representatives on its Consumer Advisory Panel and its Clean Energy Access Working Group (Joseph Williams, CEO, Youth Action Project and Trustee and Clerk of the Board, San Bernardino Community College District, along with Cid Pinedo, President, Children's Fund Inland Empire), and through its corporate philanthropy (Barstow College Foundation, Barstow Senior Citizen Center, United Way).

Norco

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there is one DAC-designated census tract in this subdivision, comprising 4,590 people out of a total population of 55,390 – 8% of the population. The majority of the subdivision falls outside of SCE's service area and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to SCE's service area. The median age of the subdivision (40.5 years) is older. The largest ethnic groups are White (57%) and Hispanic (32%). Educational attainment is about the same as the California average for high school, with the rate of bachelor's degrees or higher lower than the state

average. There are two gas-powered plants in the subdivision (Corona Cogeneration, Clear Water Cogeneration) and SCE's Mira Loma peaker gas plant is just on the western edge of the area. SCE regularly engages with the DAC-designated communities in this subdivision through its two Clean Energy Access Working Group representatives in the Riverside area (Bambi Tran and Lisa Castilone of Grid Alternatives Inland Empire).

North Antelope Valley

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there are two DAC-designated census tracts in this subdivision, comprising 12,781 people out of a total population of 261,987 – 5% of the population. The majority of the subdivision's census tracts are not rated as DACs and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues, but SCE has decided to include it because of the proximity to DAC-designated areas. The median age of the subdivision (33.1 years) is slightly younger. Median household income is about 60% of statewide levels, with per capita income at about three-quarters the amount in the state. The largest ethnic group is Hispanic (38%), followed by White (37%), and Black (18%). 76% of adults speak Spanish in the home. Educational attainment is about the same as the average in California for high school diploma, while for bachelor's degree or higher, the rate is about one-half that of the state average. There is one combined cycle power plant in the region, the High Desert Power Plant, located in Victorville. SCE engages with the DAC-designated communities through its Local Public Affairs staff in the area.

North Coast

There are six DAC-designated census tracts in this subdivision, comprising 37,346 people out of a total population of 469,954 – 8% of the population. The DACs are located primarily along the SR-22 and I-405 freeways. The population of the subdivision is older (median of 42.4 years) than for the county and the state, and the household income levels are about the same as for the county, but higher than for the state. The largest ethnic group is White (51%), followed by Asian (24%) and Hispanic (20%). Educational attainment is mixed, with

high school graduation levels a little higher than the county and state levels, but bachelor's degree attainment lower than the county average. Two gas power plants are in the Huntington Beach area near the coast. One is owned by AES and the other by the Orange County Sanitation District. The sanitation district owns and operates another gas plant in nearby Fountain Valley. SCE regularly engages with the DAC-designated communities in the North Coast subdivision through its Consumer Advisory Panel representatives for the Orange County area (Charles Dorsey of the National Diversity Coalition and Reverend Frank Jackson Jr. of Village Solutions Foundation in Irvine). Reverend Jackson also represents the Orange County area as a member of the Clean Energy Access Working Group.

Ontario

There are 60 DAC-designated census tracts in this subdivision, comprising 309,596 people out of a total population of 717,751 – 43% of the population. The DACs are located in the heart of the subdivision and especially near transit corridors (e.g., I-10 and CA-60 freeways). The population of the subdivision is slightly younger (median of 35.1 years), and has a slightly higher per person income when compared with both the county and state average. The largest ethnic group is Hispanic (50%), followed by White (29%) and Asian (12%). 32% of adults speak Spanish in the home. Educational attainment is a little higher compared to the county, but slightly less than the state average. There are several power plants in the area: the Etiwanda generating station (owned by NRG), Etiwanda peaker plant (owned by SCE), and Etiwanda hydro recovery plant (owned by the Metropolitan Water District) are all located in the northern portion of the subdivision in a DAC area. Ontario Linerboard Mill, a gas plant owned by New-Indy Ontario LLC, is also located in a DAC area. SCE regularly engages with the DAC-designated communities in the Ontario subdivision through representatives on its Consumer Advisory Panel (Cid Pinedo, Children's Fund Inland Empire, and Joseph Williams of the San Bernardino Community College District Board). SCE also engages through its Clean Energy Access Working Group representative (Paul Francis, Los Angeles Cleantech Incubator).

Orosi-Cutler

There are two DAC-designated census tracts in this Tulare County subdivision, comprising 14,371 people out of a total population of 26,929 – 53% of the population. The population of the subdivision is younger (mean of 27.8 years), and the household income levels are about one-half the average level for California. The largest ethnic group is Hispanic (87%). Educational attainment is lower, with high school graduation levels lower than the county and state levels, and bachelor degree attainment about one-fifth of the average in California. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Oxnard

There are six DAC-designated census tracts in this subdivision, comprising 26,914 people out of a total population of 256,360 – 10% of the population. The DACs are located primarily in the northern section of the subdivision, near the US-101 freeway and the Camarillo Airport, and in the south near the naval base. The population of the subdivision is slightly younger (median of 31.4 years), and has a lower per person income and lower household income compared with the county and state average. The poverty rate is above both the county and state average. The largest ethnic group is Hispanic (72%), followed by White (16%) and Asian (7%). 65% of children and 57% of adults speak Spanish in the home. Educational attainment is below the county and state levels; in particular, bachelor's degree attainment is about one-half the county and state average. There are eight power plants scattered throughout the subdivision. Two of those plants are located in the south, in the heart of the DAC area: the New-Indy Containerboard Ontario plant (owned by New-Indy Oxnard LLC) and the Ormond Beach generating station (owned by NRG). SCE regularly engages with the DAC-designated communities in the Oxnard subdivision through its Consumer Advisory Panel representative (Bernardo Perez of the Ventura County Community College District).

Perris Valley

There are 14 DAC-designated census tracts in this subdivision, comprising 89,706 people out of a total population of 357,539 – 25% of the population. The DACs are located in the heart

of the valley along the I-215 and CA-74 freeways. The population of the subdivision is slightly younger (median of 31.9 years). It has a lower per person income than the county and a much lower per person income than the state; as such, its poverty rate is above both the county and state average. The largest ethnic group is Hispanic (53%), followed by White (29%) and Black (10%). 38% of adults speak Spanish in the home. Educational attainment for high school is a little less than the county and state levels, with bachelor's degree attainment significantly below the county and state levels. There are two power plants located in the subdivision, near the I-215 freeway and in proximity to DACs: a gas plant owned by the city of Riverside's Public Utilities Department, and a gas plant owned by the Inland Empire Energy Center. SCE regularly engages with the DAC-designated communities in the Perris Valley subdivision through its two Clean Energy Access Working Group representatives in the Riverside area (Bambi Tran and Lisa Castilone of Grid Alternatives Inland Empire).

Pixley

There are four DAC-designated census tracts in this Tulare County subdivision, comprising 27,855 people out of a total population of 27,855 – 100% of the population. The median age in the county subdivision is 20.3 years, far lower than the California median. Household income levels are lower, at approximately one-half the California average. Per capita income falls to about one-third the California average. The largest ethnic group is Hispanic (89%). Educational levels are lower, with high school graduation levels lower than county and state levels, and bachelor's degree attainment around 10% of the rate in California. SCE engages with the DAC-designated communities in this subdivision through its Local Public Affairs staff, via a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization).

Porterville

There are nine DAC-designated census tracts in this Tulare County subdivision, comprising 58,670 people out of a total population of 99,906 – 59% of the population. The median age in the subdivision (29.3 years) is lower than the California median. Household

income levels are 60% the level for California, with per capita income amounting to about one-half the state average. The largest ethnic group is Hispanic (66%) followed by White (27%). 51% of adults speak Spanish in the home. Educational levels are lower, with high school graduation levels lower than county and state levels, and bachelor's degree attainment about one-third of the rate in California. SCE engages with the DAC-designated communities in this subdivision through its Local Public Affairs staff, and via a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization).

Riverside

There are 31 DAC-designated census tracts in this subdivision, comprising 153,403 people out of a total population of 314,098 – 49% of the population. The DACs are located along the CA-91 and CA-60 freeways, near the city of Riverside and to the north. The population of the subdivision is slightly younger (median of 31.3 years), and it has a lower per person income and lower household income compared with the county and state average. The poverty rate is slightly higher than for the county, and 20% higher than the state poverty rate. The largest ethnic group is Hispanic (54%), followed by White (28%) and Black (9%). 36% of adults speak Spanish in the home. Educational attainment is below the county and state levels; bachelor's degree attainment is about three-fifths the state average. Two power plants lie at the edges of this subdivision, along with four gas plants situated just over the line in San Bernardino County. All of these power plants are located within DACs. SCE regularly engages with the DAC-designated communities in the Riverside subdivision through its two Clean Energy Access Working Group representatives in the Riverside area (Bambi Tran and Lisa Castilone of Grid Alternatives Inland Empire).

San Bernardino

There are 97 DAC-designated census tracts in this subdivision, comprising 542,420 people out of a total population of 906,695 – 60% of the population. The DACs are located in the heart of the subdivision along the I-10 and I-215 freeways near the city of San Bernardino.

The population of the subdivision is slightly younger (median of 30.4 years), and it has a lower per person income and lower household income compared with the county and state average. The poverty rate is higher than for the county and for the state. The largest ethnic group is Hispanic (63%), followed by White (20%) and Black (9%). 45% of adults speak Spanish in the home. Educational attainment is below the county and state levels; bachelor's degree attainment is about one-half the state average. Several gas power plants are scattered throughout this subdivision: Drews-Agua Mansa and Century Alliance (both owned by Colton Power LP), Loma Linda Cogeneration (owned by the city), and Mountainview, Ontario 1, and Ontario 2 (owned by SCE). All of these power plants lie within DACs. SCE regularly engages with the DAC-designated communities in the San Bernardino subdivision through representatives on its Consumer Advisory Panel (Cid Pinedo of the Children's Fund Inland Empire, and Joseph Williams of the San Bernardino Community College District Board). Joseph Williams also represents the DACs as a member of the Clean Energy Access Working Group.

San Fernando Valley

There are three DAC-designated census tracts in this subdivision, comprising 10,704 people out of a total population of 141,805 – 8% of the population. The DACs are located in the heart of the valley along the I-5, SR-170, and I-210 freeways. The population of the subdivision is slightly older (median of 37.1), and it has a slightly higher per person/household income compared to the county, and slightly lower per person and household incomes compared to the state. Its poverty rate is about the same as the county and state average. The largest ethnic group is Hispanic (43%), followed by White (40%) and Asian (11%). 40% of adults speak Spanish in the home. Educational attainment is about the same as the county and state levels. Several power plants are scattered throughout the subdivision and not far from the freeways: a gas plant owned by Burbank Water and Power, a gas plant associated with CBS Studios, a gas plant owned by the Metropolitan Water District, and three gas plants owned by the LADWP. SCE regularly engages with the DAC-designated communities in the San Fernando Valley

subdivision through its Local Public Affairs staff and relationships with several Los Angeles-based Clean Energy Access Working Group representatives.

San Gorgonio Pass

There are three DAC-designated census tracts in this subdivision, comprising 12,708 people out of a total population of 105,313 – 12% of the population. Within this region, 64% of residents are Latino, 26% are White, and the population is slightly older than the California average. The DACs are located where the CA-60 and I-10 freeways diverge. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Santa Monica

There is one DAC-designated census tract in this subdivision, comprising 5,867 people out of a total population of 89,736 – 7% of the population. This is a singular DAC surrounded by a large urban non-DAC area. The population of this tract is 7% children under 10 and 11% elderly over 65. Median household income is above statewide levels, with per capita more than double the amount in the state. The largest ethnic groups are Hispanic (37%), White (36%), and Asian (14%). Educational attainment is about 20% higher than the rate in California for high school diploma, while for bachelor's degree or higher, the rate is more than double that of the state average. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Searles Valley

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there is one DAC-designated census tract in this subdivision, comprising 3,846 people out of a total population of 30,728 – 13% of the population. The majority of the subdivision's census tracts are not considered DACs and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to SCE's service area. The median age of the subdivision (47.7 years) is higher than the state average. Median household income is three-fifths the state average, with per capita income three-quarters the average. The largest ethnic group is White (82%) followed by Hispanic

(10%). 93% of adults speak English in the home. Educational attainment is a little higher for high school, and for bachelor's degrees the level is lower, at about one-fifth that of the statewide average. SCE engages with the community through its Local Public Affairs staff in the area.

Shafter

There is one DAC-designated census tract in this Kern County subdivision, comprising 15,845 people out of a total population of 15,845 – 100% of the population. The population of the subdivision is younger (median of 28 years), and has a median household income that is two-thirds of the California average. The largest ethnic group is Hispanic (78%). 63% of adults speak Spanish in the home. Educational attainment is about two-thirds of the state average for high school, and about one-fifth of the rate for bachelor's degree. SCE regularly engages with the DAC-designated communities in this subdivision, including through a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization).

South Antelope Valley

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there is one DAC-designated census tract in this subdivision, comprising 8,267 people out of a total population of 330,330 – 3% of the population. The majority of the subdivision's census tracts are not rated as DACs and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to SCE's service area. The median age of the subdivision (32.7 years) is younger than the state average. Median household income is slightly lower than statewide levels, with per capita income at about three-quarters the amount in the state. The largest ethnic group is Hispanic (53%), followed by White (29%), and Black (10%). 62% of adults speak English in the home. Educational attainment is slightly lower than the average in California for high school diplomas, while for bachelor's degree or higher, the rate is about one-half that of the state average. There is one combined cycle power plant in the region, the High Desert Power Plant, located in Victorville. SCE engages with the community through its Local Public Affairs staff in the area.

South Bay Cities

There are four DAC-designated census tracts in this subdivision, comprising 21,899 people out of a total population of 205,746 – 11% of the population. The median age of the subdivision (40.9 years) is older than the state average. Median household income is above statewide levels, with per capita income more than double the amount in the state. The largest ethnic group is White (69%) followed by Hispanic (14%). 80% of adults speak English in the home. Educational attainment is 20% higher than the rate in California for high school diploma, while for bachelor's degree or higher, the rate is double that of the state average. There are no large power plants in the county subdivision. There are several small cogeneration facilities in the broader region, including adjacent subdivisions. The general region also contains gas refineries. SCE engages with organizations and individuals who represent this region. Derek Steele, Health Equity Programs Director for the Social Justice Learning Institute, participates in the Clean Energy Access Working Group. Social Justice Learning Institute is based in Inglewood, California, which is adjacent to the South Bay Cities county subdivision.

South Gate - East Los Angeles

There are 126 DAC-designated census tracts in this subdivision, comprising 552,807 people out of a total population of 619,688 – 89% of the population. It is located along the I-710 corridor. The I-10 freeway, where it intersects I-710, is located at the northern end of the subdivision. The average age in the county subdivision is 30.1 years, which is younger than the California average. Household and per capita income are approximately 62% and 43% of the California average, respectively. The largest ethnic group is Hispanic (95%), followed by White (2%) and Black or Asian (2%). 89% of the adult population speaks Spanish at home. High school graduation and college graduation rates are lower than the California averages. There are no large power plants in the county subdivision. There are several small cogeneration facilities in the broader region, including adjacent subdivisions. SCE regularly engages with the DAC-designated communities in this subdivision including through representatives on its Clean Energy Access Working Group and environmental justice stakeholders (EarthJustice, Right to

Zero, East Yard Communities). SCE also regularly engages these stakeholders on transportation electrification issues.

Southwest San Gabriel Valley

There are 39 DAC-designated census tracts in this subdivision, comprising 168,557 people out of a total population of 410,662 – 41% of the population. The average age in the county subdivision is 41.1 years, which is older than the California average. Household and per capita income are 81% and 75% of the California average, respectively. The largest ethnic group is Asian (49%), followed by Hispanic (41%) and White (8%). The most common language other than English spoken by adults at home is Asian/Islander, and 46% of adults speak this language at home. High school graduation and college graduation rates are slightly lower than the California averages. There are no large power plants in the county subdivision. There are several small cogeneration facilities in the broader region, including in adjacent subdivisions. SCE regularly engages with organizations and individuals who represent this region. Thomas Wong, who serves on the Board of Directors for the San Gabriel Valley Municipal Water District and the Board of Climate Resolve, participates in SCE's Consumer Advisory Panel.

Springville-Johnsondale

There are three DAC-designated census tracts in this Tulare County subdivision, comprising 19,491 people out of a total population of 45,369 – 43% of the population. The median age of the subdivision (48.9 years) is 40% higher than the state average. Median household income is lower than the California average; however, per capita income is about the same as the state average. The largest ethnic group is White (62%), followed by Native American (17%) and Hispanic (14%). 91% of adults speak English in the home. Educational attainment is higher compared to the state for high school, with about three-fifths of the state average for bachelor's degree or higher. SCE engages with the DAC-designated communities through its Local Public Affairs staff.

Stratford

There are four DAC-designated census tracts in this Kings County subdivision, comprising 24,248 people out of a total population of 26,755 – 91% of the population. The median age of the subdivision (37.9 years) is only slightly higher than the state average. Median household income is lower than the California average, as is per capita income. The largest ethnic group is Hispanic (58%) followed by White (20%) and Black (14%). 43% of adults speak Spanish in the home. Educational attainment is lower compared to the state for high school, with the level of bachelor's degrees or higher at about 10% of the California average. Courtney Kalashian, Executive Director of the San Joaquin Valley Clean Energy Organization, is a member of SCE's Consumer Advisory Panel. Tom Knox, Executive Director of Valley Clean Air Now, is a member of the Clean Energy Access Working Group.

Strathmore

There are five DAC-designated census tracts in this subdivision, comprising 33,077 people out of a total population of 56,127 – 59% of the population. The average age in the county subdivision is 33.8 years old, which is younger than the California average. Household and per capita income are 57% and 48% of the California average, respectively. The largest ethnic group is Hispanic (71%), followed by White (28%) and Asian (1%). The most common language other than English spoken by adults at home is Spanish, and 58% of adults speak this language at home. High school graduation and college graduation rates are lower than the California averages. There are no large power plants in the county subdivision, but there are several solar photovoltaic plants throughout the broader region. SCE regularly engages with organizations and individuals who represent this region. Courtney Kalashian, Executive Director of the San Joaquin Valley Clean Energy Organization, is a member of SCE's Consumer Advisory Panel. Tom Knox, Executive Director of Valley Clean Air Now, is a member of the Clean Energy Access Working Group.

Tehachapi

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there are two DAC-designated census tract in SCE's service area in this subdivision, comprising 11,310 people out of a total population of 64,817 – 17% of the population. The majority of the rural subdivision falls in PG&E's service area and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to SCE's service area. The median age of the subdivision (42.3 years) is higher than the state average. Median household income is about the same as the state average, with per capita income only slightly lower than the average. The largest ethnic group is White (66%) followed by Hispanic (26%). 81% of adults speak English in the home. Educational attainment is a little higher than the state average for high school, and for bachelor's degrees it is about one-half that of the statewide average. SCE regularly engages with organizations and individuals who represent this region. Courtney Kalashian, Executive Director of the San Joaquin Valley Clean Energy Organization, is a member of SCE's Consumer Advisory Panel. Tom Knox, Executive Director of Valley Clean Air Now, is a member of the Clean Energy Access Working Group.

Terra Bella

There are three DAC-designated census tracts in this subdivision, comprising 21,326 people out of a total population of 32,338 – 66% of the population. It is located on the outskirts of the City of Delano. The median age of the subdivision (27.5 years) is much younger than the state. Per person income is 40% of the state average, with median household income only slightly higher at one-half the state average. Approximately 33% of the subdivision lives below the poverty line, which is more than double the state average. The largest ethnic group is Hispanic (81%) followed by White (14%). 73% of the population speaks Spanish at home, more than double the state average. Educational attainment is only 40% of the state average for high school graduation and bachelor's degree attainment is less than 25% of the state average. SCE engages with the DAC-designated communities in this subdivision through its Local Public

Affairs staff, via a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization), and through its corporate philanthropy (Bakersfield College – Delano).

<u>Tipton</u>

There are five DAC-designated census tracts in this subdivision, comprising 31,419 people out of a total population of 42,889 – 73% of the population. The average age in the county subdivision is 25.8 years old, which is younger than the California average. Household and per capita income are 51% and 35% of the California average, respectively. The largest ethnic group is Hispanic (86%), followed by White (13%) and two or more (1%). The most common language other than English spoken by adults at home is Spanish, and 78% of adults speak this language at home. High school graduation and college graduation rates are much lower than the California average. There are no large power plants in the county subdivision. The Pixley cogeneration facility in in an adjacent subdivision, and there are solar photovoltaic plants throughout the region. SCE regularly engages with organizations and individuals who represent this region. Courtney Kalashian, Executive Director of the San Joaquin Valley Clean Energy Organization, is a member of SCE's Consumer Advisory Panel. Tom Knox, Executive Director of Valley Clean Air Now, is a member of the Clean Energy Access Working Group.

<u>Torrance</u>

There are four DAC-designated census tracts in this subdivision, comprising 12,509 people out of a total population of 188,258 –7% of the population. The average age in the county subdivision is 41.7 years old, which is older than the California average. Both household and per capita income are higher than the California average. The largest ethnic group is White (40%), followed by Asian (34%) and Hispanic (18%). The most common language other than English spoken by adults at home is Asian/Islander, and 22% of adults speak this language at home. High school graduation and college graduation rates are higher than the California averages. There are no large power plants in the county subdivision. There are several small cogeneration facilities in the broader region, including adjacent subdivisions. The general region

also contains gas refineries. SCE engages with organizations and individuals who represent this region. Derek Steele, Health Equity Programs Director for the Social Justice Learning Institute, participates in the Clean Energy Access Working Group. The Social Justice Learning Institute is based in Inglewood, California, which is adjacent to the Torrance county subdivision.

Tulare

There are eight DAC-designated census tracts in this subdivision, comprising 36,036 people out of a total population of 94,593 – 38% of the population. The average age in the county subdivision is 30 years old, which is younger than the California average. Household and per capita income are 73% and 60% of the California average, respectively. The largest ethnic group is Hispanic (58%), followed by White (35%) and Black (3%). The most common language other than English spoken by adults at home is Spanish, and 39% of adults speak this language at home. High school graduation and college graduation rates are lower than the California averages. There are no large power plants in the county subdivision. There are several solar photovoltaic plants throughout the broader region. SCE regularly engages with organizations and individuals who represent this region. Courtney Kalashian, Executive Director of the San Joaquin Valley Clean Energy Organization, is a member of SCE's Consumer Advisory Panel. Tom Knox, Executive Director of Valley Clean Air Now, is a member of the Clean Energy Access Working Group.

Twentynine Palms-Yucca Valley

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there is one DAC-designated census tract in this subdivision, comprising 3,846 people out of a total population of 87,201 – 4% of the population. The majority of the subdivision's census tracts are not rated as DACs and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity to DAC-designated areas. The median age of the subdivision (33.4 years) is slightly younger than the state average. Median household income is about 60% of statewide levels, with per capita at about two thirds the amount in the state. The largest ethnic groups are White (66%) and

Hispanic (20%). 88% of adults speak English in the home. Educational attainment is slightly higher than the rate in California for high school diploma, while for bachelor's degree or higher, the rate is less than one-half that of the state average. SCE engages with the DAC-designated communities through its Local Public Affairs staff and relationships with the Mojave Valley United Way, the Barstow Senior Center, and the Barstow College Foundation.

Upper San Gabriel Valley

There are 46 DAC-designated census tracts in this subdivision, comprising 198,150 people out of a total population of 388,718 – 51% of the population. The DACs are located primarily along the I-10 and I-605 freeways. The population of the subdivision is slightly older (median of 39.3 years), and it generally has a lower per person income compared to the rest of the county and the state. Its poverty rate is about the same as the county and state average. The largest ethnic group is Hispanic (44%), followed by Asian (34%) and White (18%). 41% of children and 34% of adults speak Spanish in the home. Educational attainment is just below the county and state levels. No power plants are directly in the subdivision, but one gas plant (owned by the city of Pasadena) lies just outside the area to the east. SCE regularly engages with the DAC-designated communities in the Upper San Gabriel Valley subdivision through its Consumer Advisory Panel representative (Thomas Wong of Climate Resolve, San Gabriel Valley Municipal Water District). Additionally, the Clean Energy Access Working Group representative nearby in Fresno is Jasna Tomic of CALSTART, an organization that supports a cleaner transportation industry.

Ventura

An ArcGIS analysis of DAC census tracts and SCE's service area indicates that there are three DAC-designated census tracts in this subdivision, comprising 15,479 people out of a total population of 146,499 – 11% of the population. The majority of the subdivision's census tracts are not rated as DACs and the overlap of the subdivision and SCE's service area may be the result of ArcGIS layering issues; regardless, SCE has included it here due to its proximity DAC-designated areas. The median age of the subdivision (38.8 years) is slightly older than the state

average. Median household income is slightly higher than statewide levels, as is per capita income. The largest ethnic groups are White (36%) and Hispanic (35%). 73% of adults speak English in the home. Educational attainment is about 10% higher than the rate in California for high school diploma, while for bachelor's degree or higher, the rate is about the same as the state average. There are eight power plants scattered throughout the subdivision. Two of those plants are located in the south, within a DAC: the New-Indy Containerboard Ontario plant (owned by New-Indy Oxnard LLC) and the Ormond Beach generating station (owned by NRG). SCE regularly engages with the DAC-designated communities in the Oxnard subdivision through its Consumer Advisory Panel representative (Bernardo Perez of the Ventura County Community College District).

Victorville-Hesperia

There are eight DAC-designated census tracts in this subdivision, comprising 46,573 people out of a total population of 418,357 – 11% of the population. The average age in the county subdivision is 32.4 years old, which is younger than the California average. Household and per capita income are 73% and 59% of the state average, respectively. The largest ethnic group is Hispanic (47%), followed by White (37%) and Black (10%). The most common language other than English spoken by adults at home is Spanish, and 26% of adults speak this language at home. High school graduation and college graduation rates are lower than the California averages. The High Desert Power Plant is an 830 MW, combined cycle power plant located in Victorville, but the plant is located in census tract 6071980200, which does not qualify as a DAC. That census tract does not have enough population to be able to quantify its CalEnviroScreen score, but its pollution burden is in the 49th percentile statewide. There are several small facilities in the general region, including solar photovoltaic power plants. SCE engages with the community through its Local Public Affairs staff in the area.

Visalia

There are 10 DAC-designated census tracts in this subdivision, comprising 73,056 people out of a total population of 174,889 – 42% of the population. The average age in the county

subdivision is 31.8 years old, which is younger than the California average. Household and per capita income are 80% and 72% of the California average, respectively. The largest ethnic group is Hispanic (50%), followed by White (41%) and Asian (5%). The most common language other than English spoken by adults at home is Spanish, and 28% of adults speak this language at home. High school graduation and college graduation rates are lower than the California averages. There are no large power plants in the county subdivision. There are several solar photovoltaic plants throughout the broader region. SCE regularly engages with organizations and individuals who represent this region. Courtney Kalashian, Executive Director of the San Joaquin Valley Clean Energy Organization, is a member of SCE's Consumer Advisory Panel. Tom Knox, Executive Director of Valley Clean Air Now, is a member of the Clean Energy Access Working Group.

Wasco

There is one DAC-designated census tract in this Kern County subdivision, comprising 15,845 people out of a total population of 15,845 – 100% of the population. The median age of the subdivision (27.5 years) is younger than the state average. Median household income is about 60% of statewide levels, with per capita at about one-third the amount in the state. The largest ethnic group is Hispanic (81%). 69% of adults speak Spanish in the home. Educational attainment is about two-thirds of the rate in California for high school diploma, while for bachelor's degree or higher, the rate is less than one-fifth that of the state average. SCE regularly engages with the DAC-designated communities in this subdivision, including through a representative on its Consumer Advisory Panel and its Clean Energy Access Working Group (Courtney Kalashian, San Joaquin Valley Clean Energy Organization).

Whittier

There are 44 DAC-designated census tracts in this subdivision, comprising 192,928 people out of a total population of 440,456 – 44% of the population. The DACs are clustered along the I-605 freeway and just south of the 60 freeway. The population of the subdivision is about the same or slightly older (median of 36.1 years), and it has lower per person income than

the county and state averages. The largest ethnic group is Hispanic (71%), followed by White (19%) and Asian (7%). 48% percent of adults speak Spanish in the home. Educational attainment for high school is about the same as county and state rates; however, bachelor's degree attainment is much lower than for the county and the state. Several power plants are located throughout the subdivision: Rio Hondo (a hydro plant owned by the Metropolitan Water District), Puente Hills Energy Recovery (owned by LA County Sanitation Districts and run on landfill gas), Whittier LFG (owned by J&A Santa Maria and run on landfill gas), Center Peaker (a gas plant owned by SCE), and gas plants owned by Biola University and Wheelabrator Technologies Inc. SCE regularly engages with the DAC-designated communities in the Whittier subdivision through its Local Public Affairs staff and relationships with several Los Angeles-based Clean Energy Access Working Group representatives.

Woodlake-Three Rivers

There is one DAC-designated census tract in this subdivision, comprising 6,200 people out of a total population of 40,548 – 15% of the population. The population is older (median of 38.1 years), and its per person income is about two-thirds lower than the state level. The largest ethnic group is Hispanic (62%) followed by White (35%). 43% percent of adults speak Spanish in the home. Educational attainment is about the same or below the county and state averages; however, bachelor's degree attainment is three-fifths lower than the state average. Four hydro-power plants can be found in the southeastern portion of the subdivision: Terminus Hydroelectric Project (owned by the Kaweah River Power Authority), and Kaweah 1, 2, and 3 (owned by SCE). SCE regularly engages with the DAC-designated communities in the Woodlake-Three Rivers subdivision through its Local Public Affairs staff. The area is also represented through the Consumer Advisory Panel's Courtney Kalashian of the San Joaquin Valley Clean Energy Organization, who is also a member of the Clean Energy Access Working Group.

Appendix I.1

CNS Calculator (GHG) – SCE Conforming Portfolio

SEE NOTICE OF AVAILABILITY FOR
APPENDIX I.1

Appendix I.2

CNS Calculator (NOx) – SCE Conforming Portfolio

SEE NOTICE OF AVAILABILITY FOR
APPENDIX I.2

Appendix I.3

CNS Calculator (PM2.5) – SCE Conforming Portfolio

SEE NOTICE OF AVAILABILITY FOR
APPENDIX I.3

Appendix J

Acronym List

Acronym	Term
2014 Conformed BPP	Assembly Bill 57 Conformed Bundled Procurement Plan
2017 Scoping Plan	California's 2017 Climate Change Scoping Plan
A.	Application
AAEE	Additional Achievable Energy Efficiency
AAPV	Additional Achievable Photovoltaic
AB	Assembly Bill
AC	Alternating Current
ACES	Aliso Canyon Energy Storage
Baseline	SCE's baseline revenue and rates forecast, which is based on data submitted in the 2017 IEPR
BCF	Billion Cubic Feet
BPP	Bundled Procurement Plan
BTM	Behind-the-Meter
Business Plan	Energy Efficiency Business Plan
CAGR	Compounded Annual Growth Rate
CAISO	California Independent System Operator
CA	California
CAM	Cost Allocation Mechanism
CARB	California Air Resources Board
CARE	California Alternate Rates for Energy
CCA	Community Choice Aggregator
CCGT	Combined Cycle Gas Turbine
CEC	California Energy Commission
CHP	Combined Heat and Power
CNG	Compressed Natural Gas
CNS	Clean Net Short
CO2e	Carbon Dioxide Equivalent

Acronym	Term
COL	Conclusion of Law
Commission	California Public Utilities Commission
Conforming Scenario	Conforming scenario based on inputs and assumptions used in the Commission's Reference System Plan and the 2017 IEPR
Coso	Coso Geothermal Power Holdings LLC
CPM	Capacity Procurement Mechanism
CPUC	California Public Utility Commission
CRVM	Common Resource Valuation Methodology
Current Policy Scenario	Economy-wide, business-as-usual scenario used in SCE's GHG scenario analysis that reflected then current legislative and regulatory policies that impacted GHG emissions
D.	Decision
DA	Direct Access
DAC	Disadvantaged Community
DCFC	Direct Current Fast Charge
DER	Distributed Energy Resource
E3	Energy+Environmental Economics
EE	Energy Efficiency
EGT	Enhanced Gas Turbine
ELCC	Effective Load Carrying Capability
EO	Energy-Only
ESA	Energy Savings Assistance
ESP	Electric Service Provider
ESP&IP	Energy Storage Procurement & Investment Plan
EV	Electric Vehicle
FCDS	Full Capacity Deliverability Status
FOF	Finding of Fact
GAM/PMM	Green Allocation Mechanism/Portfolio Monetization Mechanism
GHG	Greenhouse Gas

Acronym	Term
GRC	General Rate Case
GW	Gigawatt
GWh	Gigawatt-Hour
H2	Hydrogen
HDV	Heavy-Duty Vehicle
I-	Interstate
IC	Internal Combustion
ICF and E3 TEA	ICF International and E3 California Transportation Electrification Assessment study
IDER	Integrated Distributed Energy Resources
IEPR	Integrated Energy Policy Report
IOU	Investor-Owned Utility
IRP	Integrated Resource Plan or Integrated Resource Planning
kW	Kilowatt
kWh	Kilowatt-Hour
LADWP	Los Angeles Department of Water and Power
LCR	Local Capacity Requirements
LDC	Local Distribution Company
LDV	Light-Duty Vehicle
LGBT	Lesbian, Gay, Bisexual, Transgender
LMDR	Load Modifying Demand Response
LSE	Load-Serving Entity
LTPP	Long-Term Procurement Plan
MDV	Medium-Duty Vehicle
MMcfd	Million Cubic Feet per Day
MMT	Million Metric Tons
MT	Metric Ton
MW	Megawatt

Acronym	Term
MWh	Megawatt-Hour
NEM	Net Energy Metering
NOx	Nitrogen Oxides
NPV	Net Present Value
O&M	Operations and Maintenance
OP	Ordering Paragraph
OTC	Once-Through Cooling
Pathway	SCE's Clean Power and Electrification Pathway
Pathway Scenario	Pathway scenario based on SCE's GHG scenario analysis combined with SCE-internal electric load and load growth forecasts in a scenario that complies with California's 2030 GHG emissions limit
PCIA	Power Charge Indifference Adjustment
PG&E	Pacific Gas and Electric Company
PM2.5	Fine Particulate Matter
Pmin	Plant Minimum Load
PSLF	Positive Sequence Load Flow
PV	Photovoltaic
R.	Rulemaking
RA	Resource Adequacy
RAS	Remedial Action Scheme
RETI	Renewable Energy Transmission Initiative
RFO	Request for Offers
RFP	Request for Proposals
RMR	Reliability Must-Run
RNG	Renewable Natural Gas
ROW	Right-of-Way
RPS	Renewables Portfolio Standard
SASH	Solar for Affordable Housing

Acronym	Term
SB	Senate Bill
SCE	Southern California Edison Company
SCE Conforming Portfolio	SCE bundled portfolio using inputs and assumptions from the Commission's Reference System Plan and the 2017 IEPR
SCE Pathway System Plan	SCE's alternative CAISO system-wide plan based on SCE's Pathway for meeting California's 2030 GHG emissions goal, including a 28 MMT GHG emissions planning target for the electric sector
SCE Preferred Portfolio	SCE bundled portfolio based on the targets and constraints in the SCE Pathway System Plan applied at the SCE bundled level
SDG&E	San Diego Gas & Electric Company
SoCalGas	Southern California Gas Company
SR	State Route
STAR-certified	Standardized Testing and Reporting program Certified
System-Optimized Storage Resource	Energy storage that is optimally located and operated maximizes its benefits for both customers and the electric grid by most effectively serving both market and grid needs
TCO	Total Cost of Ownership
TE	Transportation Electrification
TOU	Time-of-Use
TPP	Transmission Planning Process
Valley CAN	Valley Clean Air Now
WECC	Western Electricity Coordinating Council
ZEV	Zero Emissions Vehicle
ZNE	Zero-Net Energy